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AMERICAN ELECTRIC RAILWAY

ENGINEERING ASSOCIATION

1915

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CONTAINING A COMPLETE REPORT OF THE THIRTEENTH ANNUAL CONVENTION, HELD AT NATIVE SONS OF GOLDEN WEST BUILDING, SAN FRANCISCO, CAL., OCTOBER 4, 5, 6, 7 and 8, 1915

PUBLISHED BY THE
AMERICAN ELECTRIC RAILWAY ASSOCIATION
FROM THE OFFICE OF THE SECRETARY
8 WEST 40TH STREET, NEW YORK, N. Y.

PRESIDENT 1914–1915
L. P. CRECELIUS
SUPERINTENDENT OF POWER AND ELECTRICAL ENGINEER
THE CLEVELAND RAILWAY CO.
CLEVELAND, OHIO

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C

THE NAME OF THIS ASSOCIATION WAS FORMERLY THE

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION

ORGANIZED AT CLEVELAND, OHIO, FEBRUARY 16, 1903.

REORGANIZED AT PHILADELPHIA, PA., SEPTEMBER 25, 1905

UNDER THE NAME OF

AMERICAN STREET AND INTERURBAN RAILWAY ENGINEERING ASSOCIATION

THE NAME OF THIS ASSOCIATION IS NOW

AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION

(CHANGE MADE AT 1910 ATLANTIC CITY CONVENTION).

J. B. LYON COMPANY, PRINTERS
ALBANY, N. Y.

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NATIONAL JOINT COMMITTEE ON OVERHEAD AND UNDERGROUND LINE CONSTRUCTION

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A. S. RICHEY, *Professor Electric Railway Engineering,* Worcester Polytechnic Institute, Worcester, Mass.

C. L. CADLE, *Electrical Engineer,* New York State Railways, Rochester, N. Y.

ALTERNATES

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D. E. CROUSE, *Electrical Engineer,* The Maryland Electric Railways Co., Annapolis, Md.

STANDARDIZATION COMMITTEE OF A. I. E. E. (SUB-COMMITTEE ON FLEXIBLE STRANDING)

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W. W. BROWN, *Engineer,* Brooklyn Rapid Transit System, Brooklyn, N. Y. (Representing Committee on Equipment).

TO CONFER WITH U. S. BUREAU OF STANDARDS ON SAFETY CODE

A. S. RICHEY, *Professor Electric Railway Engineering,* Worcester Polytechnic Institute, Worcester, Mass.

C. L. CADLE, *Electrical Engineer,* New York State Railways, Rochester, N. Y.

CONVENTION PROGRAM

(San Francisco, Cal., October 4, 5, 6, 7 and 8, 1915.)

MEETING ROOMS

All regular and joint sessions were held in Yosemite Hall, Native Sons of the Golden West Building, with the exception of that with the Transportation and Traffic Association, which was in the Auditorium.

Monday, October 4th — 9.30 A. M. to 12.30 P. M.

Registration and Distribution of Badges at Booth, Lobby, Native Sons of the Golden West Building.

Monday, October 4th — 2.00 P. M. to 5.00 P. M.

Convention Called to Order.

Annual Address of the President.

Annual Report of Executive Committee.

Annual Report of Secretary-Treasurer.

Appointment of Convention Committee on Resolutions.

Reports of Committees:

(*a*) Lightning Protection.
(*b*) Standards.
(*c*) Power Distribution.
(*d*) Standards (on Recommendations contained in above report).

Tuesday, October 5th — 2.00 P. M. to 5.00 P. M.

(Joint Session with Transportation and Traffic Association.)

Reports of Committees:

(*a*) Block Signals for Electric Railways.
(*b*) Standards (on Recommendations contained in above report).
(*c*) Joint Sub-committee on Block Signal Rules.
(*d*) Transportation-Engineering.

At conclusion of Joint Session.

Reports of Committees:

(*a*) Equipment.
(*b*) Standards (on Recommendations contained in above report).
(*c*) Buildings and Structures.
(*d*) Standards (on Recommendations contained in above report).

Wednesday, October 6th — 2.00 P. M. to 5.00 P. M.

(Joint Session with Accountants' Association.)

Reports of Committees:

(*a*) Engineering-Accounting.

(*b*) Life of Railway Physical Property.

At conclusion of Joint Session.

Reports of Committees:

(*a*) Constitution and By-Laws.

(*b*) Power Generation.

(*c*) Standards (on Recommendations contained in above report).

Thursday, October 7th — 2.00 P. M. to 5.00 P. M.

Reports of Committees:

(*a*) Way Matters.

(*b*) Standards (on Recommendations contained in above report).

ADDRESS — "Some Factors Affecting the Application of Wood Preservation to Electric Railways", by Messrs. Carlile P. Winslow and Clyde H. Teesdale, Forest Products Laboratory, Madison, Wis.

Reports of Committees (*Continued*):

(*c*) Heavy Electric Traction.

(*d*) Standards (on Recommendations contained in above report).

(*e*) Electrolysis.

General Business.

Report of Committee on Resolutions.

Report of Committee on Nominations.

Election of Officers.

Installation of Officers.

Adjournment.

Friday, October 8th — 11.30 A. M.

Presentation of Testimonial from Panama Pacific Exposition Company, Commemorative of the 1915 Meeting, by Exposition Officials.

MINUTES

OF THE

1915 CONVENTION

MONDAY SESSION

OCTOBER 4, 1915

The thirteenth annual Convention of the American Electric Railway Engineering Association was called to order in Yosemite Hall, Native Sons of the Golden West Building, San Francisco, Cal., at 2.20 P. M., with President Crecelius in the Chair.

PRESIDENT CRECELIUS:— Gentlemen: It is a pleasant duty for me to call this meeting to order, inaugurating the thirteenth annual convention of the American Electric Railway Engineering Association. I feel, and I am confident that most of us feel, that the Association is particularly fortunate in having chosen San Francisco as its convention city, because the citizens of our country have also chosen this city in which to celebrate the formal opening of the Panama Canal, the most stupendous engineering achievement in history. We are, of course, also very happy in the opportunity to meet and welcome our friends and associates of the Far West.

The first matter on our program is, as usual, the Address of the President.

ADDRESS OF THE PRESIDENT

The past year differs from former years of our Association's activities, I believe, only to the extent that matters which have been pending for some time have, in the majority of cases, been brought

EDITOR'S NOTE.—A complete list of names of those who participated in the discussion of the various meetings of this Convention, together with their official titles, etc., will be found on page following the minutes of the last Session.

to a successful conclusion by our various standing committees. This is evidenced by the report of the Committee on Standards, and the Association is now in a position to take on a considerable amount of new work and is therefore in need of subject matter for investigation by these committees. I have pointed out before, that the subjects for consideration must be important and timely and of more than purely local interest. They should comprise matters of vital interest to the electric railway industry as a whole. Minor questions should be submitted to the AERA question box, which has been found in the past year to be a very profitable source for the interchange of ideas, and our membership seems to have shown considerable interest therein, and this feature of the AERA is commended to your consideration.

Examination of the reports of our various standing committees indicates the interest, thoroughness and good work accomplished during the year. Accordingly, all credit for the successful outcome of the recommendations contained therein belongs to our members and such representatives of the manufacturers who have participated in the preparation of these reports. There are two matters of paramount interest which I desire to bring to your attention and which in my opinion must receive the very earnest consideration of our Association. They are, *first,* the question of arousing a larger amount of interest in the use of our Standards and Recommendations which are now available to all, due to the distribution of the *Engineering Manual;* and *secondly,* membership.

In regard to the first matter, a sub-committee of the Committee on Standards was appointed to investigate the situation with respect to the extent to which the Standards and Recommendations of the Engineering Association were being used by the member companies. Conditions revealed by this investigation were very unsatisfactory and indicated that our Standards are not being used as much as the great value of this work justifies. Now it seems that important work of this character should be taken advantage of. It must be a fact that member companies fail to appreciate, that this work is carefully prepared by the ablest men in our Association and thus is of immense value. It follows, therefore, that a primary duty of the Association will be to bring this question to an issue and to devise ways and means by which the great value of our Standards will be brought home to the member companies for the purpose of stimulating interest in their use.

In regard to the second question, *viz.,* membership, it has been pointed out in former addresses, the great desirability of a large membership in the Association and undoubtedly this is so well understood that the point need not be made again. In line with this question however, the officers of this and the American Association have hit upon the plan of including company section members into membership of the Association upon an arrangement which is felt will induce a very large class of individuals to join our Association. To make this possible it was necessary to add an amendment to the constitution

of the Engineering Association, which will be submitted to this Convention for approval. The matter, however, should not end here and every member of the Association is urged to give the question of membership his personal attention.

The secretary-treasurer's annual report upon the finances when presented for your consideration and approval, will indicate that the expenses incurred by the Engineering Association are somewhat larger than last year. This was not due, however, to the fact that the affairs of the Association have been less economically administered. It was due altogether to the very large amount of coöperative work with other societies and associations requiring frequent and prolonged conferences by our representatives.

The scope of the Engineering Association's activities is further reflected by the following list of coöperative work with other societies and associations:

1. In connection with the preparation of a National Electrical Safety Code by The National Bureau of Standards, in regard to which a number of conferences have been held.
2. Representation on the National Joint Committee on Overhead and Underground Line Construction. The activities of this committee have been very pronounced during the past year.
3. Clearances for heavy electric traction with the American Railway Association and the American Railway Engineering Association.
4. Electrolysis — representation upon the National Joint Committee upon this subject.
5. Fire Protection Rules and Car Wiring, with the National Fire Protection Association.
6. Cable Stranding, with the American Institute of Electrical Engineers.
7. Standards of Design for Block Signal Apparatus, with the Railway Signal Association.
8. Boiler Code, of the American Society of Mechanical Engineers.

In addition to the large amount of work indicated above, the details of which fell to the lot of the representatives of our various committees, they have also found time to cover fully the questions submitted to them by the Executive Committee, and included in reports which are to be considered by this Convention; consequently the year has been a very busy one for our standing and special committees. I have the further pleasure to report that the Committee on Standards has finally included in its report a proposed schedule of regulations governing the style of specifications to be adopted by the Association. You have already observed by examination of the advance copies of the reports that this year marks an epoch, in that the Committee on Power Generation has been successful in bringing forward valuable recommendations to be adopted by the Association.

To sum up, the year's work has been found to have been one of unusual activity in regard to coöperation with other societies upon very important questions and in the completion by our standing committees of many matters pending from previous years. It follows, therefore, that the duties devolving upon the secretary and his office force have been very heavy, and I have great pleasure in calling attention to the very able and satisfactory manner in which this has been taken care of by him.

In closing, I desire to express again, my great appreciation of the honor you have conferred upon me and I wish to add that I will always have a deep interest in and regard for the welfare of the Engineering Association.

PRESIDENT CRECELIUS:— The next business in order is the Report of the Executive Committee, which will be presented by Acting-Secretary Stocks.

ANNUAL REPORT OF THE EXECUTIVE COMMITTEE

To the American Electric Railway Engineering Association:

A meeting of the Executive Committee was held at the Association headquarters, New York, November 10, 1914, with President Crecelius presiding.

Those present were: Messrs. L. P. Crecelius, *President;* John Lindall, *First Vice-President;* F. R. Phillips, *Third Vice-President;* H. F. Merker, G. W. Palmer, Jr., and W. G. Gove, members of the Executive Committee, and Messrs. J. H. Hanna and Martin Schreiber, Past Presidents of the Engineering Association; also Mr. C. W. Stocks, representing Mr. E. B. Burritt, *Secretary.*

The minutes of the last meeting were approved.

Vice-President Phillips presented a tentative allotment for committee work during the year, which was approved with some minor alterations. The President was directed to request the American Association for an appropriation of $4,000 for the transaction of the year's work.

VOLTAGE CLASSIFICATION

The President then brought up for consideration the voltage classification as proposed by the Pennsylvania Department of Labor and Industry, this proposal being to classify all voltage in excess of 300 as high tension. The Secretary read correspondence had with Mr. C. L. S. Tingley and the U. S. Bureau of Standards. It developed that the matter had been referred to the Code Committee of the American Institute of Electrical Engineers.

On motion by Mr. Gove, it was voted that the President appoint Mr. J. W. Welsh, Chairman of the Committee on Power Generation, to represent the Engineering Association before the Code Committee of the American Institute of Electrical Engineers in its consideration of

this matter. The President stated that he would communicate with the American Institute of Electrical Engineers, advising them of the appointment of Mr. Welsh and requesting that he be permitted to attend the meeting of the Code Committee when this subject is under consideration, in the interest of the American Electric Railway Engineering Association, the President also to advise Mr. Welsh of his appointment as the representative in charge of the interests of the Engineering Association.

MEMBERSHIP OF PURCHASING AGENTS AND STOREKEEPERS

The matter of the membership of Purchasing Agents in the Association was next considered. Mr. Hanna explained that as a result of communications received by the Executive Committee of the American Association, suggesting a separate organization to include Purchasing Agents, that Committee had referred the matter to the Engineering Association, suggesting the formation of a special committee to handle matters in connection with such membership.

On motion by Mr. Phillips the President was directed to appoint a committee of four, one member to be a member of the Executive Committee of the Engineering Association, one member to be chosen from the Engineering Association at large, and two Purchasing Agents, to investigate and report upon the best method of handling the membership of Purchasing Agents and Storekeepers in the Association, submitting an estimate of the probable income and expenses involved in the operation of any plan submitted, the Committee also to report upon the number of Purchasing Agents and Storekeepers who have allied themselves with any of the Affiliated Associations.

FOREST PRODUCTS LABORATORY

The Secretary then read a letter from the Director of the Forest Products Laboratory of the United States Department of Agriculture at Madison, Wis., suggesting that he would be glad to have a representative attend one of the Association meetings and present a paper on the work of the Laboratory.

On motion by Mr. Phillips, it was voted that the President invite the Director of the Forest Products Laboratory of the United States Department of Agriculture to have a representative present a paper on the work of the Laboratory at the next annual Convention, with particular reference to matters of interest to the electric railways, in regard to such materials as poles, ties, bridge timbers and materials for car construction.

TENTATIVE BOILER CODE — AMERICAN SOCIETY MECHANICAL ENGINEERS

The tentative Boiler Code, as drafted by the A. S. M. E. was then presented, with a letter from the Secretary of the A. S. M. E., inviting criticism from this Association. On motion by Mr. Lindall, it was

voted that the tentative Boiler Code of the American Society of Mechanical Engineers be referred to the Committee on Power Generation for consideration and report, with particular reference to the Specification for Lapwelded and Seamless Steel Boiler Tubes, set forth on page 212 (preliminary draft, third printing). It is the sense of the Committee that the American Society of Mechanical Engineers should be notified of this action by the Secretary of the Association.

CONTINUANCE OF COMMITTEES

On motion by Mr. Palmer, the Committee voted that the Joint Committees on Engineering-Accounting and Life of Railway Physical Property be continued, and that the President recommend to the Executive Committee of the American Electric Railway Association that the Co-chairman of the Committee on Life of Railway Physical Property be included in the membership of the new Committee on Valuation to be appointed by the American Association.

On motion by Mr. Lindall, the Joint Committees on Transportation-Engineering and Block Signals were continued.

STANDARDIZATION RULES — AMERICAN INSTITUTE ELECTRICAL ENGINEERS

The Standardization Rules of the American Institute of Electrical Engineers were then brought up for consideration. On motion by Mr. Palmer, it was voted that these rules be referred to the Chairmen of the Committees on Equipment, Power Distribution, Power Generation, Block Signals and Heavy Electric Traction for consideration by their respective Committees, especially in relation to the Standards adopted by the Engineering Association, with instructions to report upon the same at the next Convention. In the event that any rule is not approved, a recommended revision should be submitted.

STANDARDS APPROVED FOR ADOPTION BY THE COMMITTEE ON STANDARDS AND THE 1914 CONVENTION

The Secretary then presented the following list of Standards and Recommendations which had received the approval of the Convention and the Standards Committee, but had not yet received the formal action of the Executive Committee:

STANDARDS

Specification for Rubber Insulated Wire and Cable for Power Distribution Purposes.

Specification for Round and Grooved High Conductivity Trolley Wire.

Note.— This is to supersede the Specification for 2/0 Hard Drawn Copper Trolley Wire, adopted as Standard in 1911 and shown as Section Dw 3a in *Engineering Manual.*

Specification for Galvanizing or Sheradizing on Iron and Steel.

Note.— This is to supersede the Specification for Galvanizing on Iron and Steel adopted as Standard in 1912 and shown as Section Df 2a in the *Engineering Manual.*

Copper Wire Tables.

Note.— These are to supersede those adopted in 1912 and now conform to the U. S. Bureau of Standards new tables as issued in second edition of Bulletin 31 under date of January 1, 1913.

Wire and Cable Terminology.

Amended definitions for "Wire" and "Concentric Lay Cables."

Specification for 600 Volt Direct Current Overhead Trolley Construction. Sections 51, 54 and 61 amended, covering "Spans — Installation on Tangents;" "Trolley Wire — Sag;" "Curves — Dressing," respectively.

Specification for Solid Wrought Carbon Steel Wheels for Electric Railway Service.

RECOMMENDATIONS

Specification for Air Brake Hose.

Diagram of Clearances for Overhead Working Conductors.

On motion by Mr. Merker, these Standards and Recommendations were approved.

On motion by Mr. Merker, it was voted that the recommendation of the Joint Committee on Block Signals for a Standard Design of Spectacle for Semaphore Signals and the Fire Protection Rules recommended by the Committee on Buildings and Structures, having been approved by the Convention, be considered by the Committee on Standards and the Executive Committee by letter ballot.

LIGHTNING PROTECTION

Mr. Palmer then brought up the action taken at the Convention, whereby the various committees were instructed to consider the subject of lightning protection in its relation to car and line equipment, and discussion was had on the general subject. On motion by Mr. Gove, it was voted that the subject of lightning protection, in its relation to car and line equipment, be considered by a special committee consisting of one representative each from the Committee on Equipment, Power Distribution, Electrolysis and Block Signals.

REPORT OF SUBCOMMITTEE TO CONSIDER RELATIONS WITH OTHER SOCIETIES

The committee then approved the report of the sub-committee appointed to consider relations with other societies, recommending that where joint action was had with any other associations or societies,

the representation from the Engineering Association on any joint committee should be by a sub-committee of the particular standing committee concerned, appointed by the Chairman of the standing committee, and that the Association should have equal representation with other associations on such joint committees.

On motion by Mr. Palmer it was voted that the code of instructions for the use of committees be amended by the addition of the following paragraph:

> Each committee chairman is instructed to review all existing Standards and Recommendations as appearing in the *Engineering Manual* and originating with his committee and report upon any revisions which may, in the judgment of his committee, be necessary.

REPORT OF COMMITTEE ON SUBJECTS

To the Executive Committee of the Engineering Association:

There was then taken up the recommendations of the Committee on Subjects as to subjects for investigation by the various committees during the ensuing year, as follows

COMMITTEE ON POWER DISTRIBUTION:

(*a*) Specification for Reinforced Concrete Poles.

(*b*) Specification for Sundry Line Materials.

(*c*) Secification for 600 Volt Direct Current Overhead Trolley Construction:

Sec. 81. Lightning Arresters — Location.

Sec. 82. Lightning Arresters — Grounds.

(*d*) Revision of Standard Specification for Tubular Steel Poles.

(*e*) Review all existing Standards and Recommendations originating with Committee on Power Distribution.

Approved.

COMMITTEE ON ELECTROLYSIS:

(*a*) That a study of the general subject be continued.

Approved.

COMMITTEE ON BLOCK SIGNALS FOR ELECTRIC RAILWAYS:

(*a*) Digest of Signal Laws and Rulings. This should show if any State Commissions make new rulings subsequent to date of information in 1914 report.

(*b*) Bibliography on Block Signal Installations — subsequent to June 1, 1914.

(*c*) Design of Standard Signal Apparatus. To coöperate with Railway Signal Association — Committee on Signaling for Electric Railways — in the adoption of Standard Signal Apparatus.

(*d*) Clearance Diagram for Semaphore Signals. This should be considered after conference with Committees on Power Distribution and Heavy Electric Traction.

(*e*) Revision of Block Signal Rules for Contactor Signals. This should be considered jointly with Committee on Rules of Transportation and Traffic Association, as Rule No. 10 was referred back to Committee.

(*f*) Light Signals for Interurban Railways. Should be given further consideration with a view to the adoption of a definite standard for sizes of lenses for light signals operated by continuous track circuits or contactors.

(*g*) On the advisability of changing Standard Light Aspects in Three Position Signaling to read from "Non-Car Counting" or "Car Counting" to "Non-Registering" or "Car Registering" Signals, as new contactor signal rules all read "Car Registering Signals."

(*h*) Study of Signal Systems on Roads that are signaled from end to end, to cover maintenance, cost, efficiency of operation and effect on traffic.

(*i*) Review all existing Standards and Recommendations originating with the Committee on Block Signals for Electric Railways.

Approved.

COMMITTEE ON TRANSPORTATION-ENGINEERING:

(*a*) Two or more Car Operation in Interurban Service.

1. Passenger Service.
2. Freight Service.

Should be given more study so as to cover costs of operation and comparative figures for single car operation.

(*b*) Effect of Car and Equipment Design on Duration of Stops, for both Passenger and Freight Service. This should be continued and should study the question of car design from a traffic standpoint in all its phases, first standardizing the methods of determining results, *i. e.,* having identical formulae and practice for obtaining observations and data from which conclusions are drawn.

(*c*) Investigation of Braking Distance on Interurban Cars with special reference to location of Block Signals.

(*d*) Review all existing Standards and Recommendations originating with the Committee on Transportation-Engineering.

Approved.

COMMITTEE ON EQUIPMENT:

(*a*) Specification for Heat Treated Carbon Steel Axles, Shafts and Similar Parts. Committee should make a study of and report upon the need of a revision of the Standard Specification adopted in 1912.

(*b*) Specification for Gears and Pinions including Tolerances.

(*c*) M. C. B. Brass for Heavy Electrical Traction. Should make a study of standard journal brass difficulties by conducting such tests as may seem necessary and to collaborate with M. C. B. Association and Committee on Heavy Electric Traction.

(*d*) Wires and Cables for Car Equipment, with special reference to Fire Protection, for both 600 and 1200-volt equipments. Should be considered jointly with N. F. P. A., especially as to use of lighter conduits in car roofs.

(*e*) Specification for Air Brake Hose. Committee should broaden Specification so as to include smaller sizes of hose.

(*f*) Lightning Protection — which has been referred to a special committee.

(*g*) Should submit Design for Limit of Wear Gauge for Flange Thickness for Association Standard Wheel.

(*h*) Revision of Steel Wheel Design to include smaller diameters.

(*i*) Review all existing Standards and Recommendations originating with Committee on Equipment.

Approved.

COMMITTEE OF BUILDINGS AND STRUCTURES:

(*a*) General Specification and Form of Contract for Railway Structures.

(*b*) Proper Provision for Expansion and Contraction in Concrete Structures, together with a provision for properly waterproofing and protecting such arrangements for providing for expansion and contraction. This subject should be considered along broad lines of application either to thin slab construction or massive monolithic work, also having in mind the carrying of reinforcement throughout either of these various types of work.

(*c*) Further consideration of Fire Protection Rules, especially with regard to the use of soldering or other heating equipment.

(*d*) Design of Standard Fireproof Substation Building of 1,000 kw. capacity.

(*e*) Review all existing Standards and Recommendations originating with Committee on Buildings and Structures.

Approved.

COMMITTEE ON ENGINEERING-ACCOUNTING:

(*a*) Cost Accounting. Draft a set of standard forms for use with the system recommended by the 1914 Committee.

(*b*) Revision of Subdivision of operating maintenance accounts to meet new I. C. C. classification.

(*c*) Development of a proper ledger looking towards the maintenance of a continuous inventory.

Approved.

COMMITTEE ON LIFE OF RAILWAY PHYSICAL PROPERTY:

(*a*) General subject to be continued.

Approved.

COMMITTEE ON POWER GENERATION:

(*a*) Report on Good Practice in regard to Smoke Abatement from the standpoint of smoke observations and appliances and devices used for determining smoke density.

(*b*) Specification for Boiler Tubes, considering the question from the standpoint of both open hearth seamless hot drawn steel tubing and charcoal iron tubes.

(*c*) Specification for purchase of fuel and power station lubricants.

(d) The Committee suggests that the President notify the Chairman of the Committee on Power Generation of the desirability of coöperating with the Committee on Prime Movers of the National Electric Light Association and the Committee on Power Stations of the American Institute of Electrical Engineers on any question of subjects of mutual interest.

(*e*) Review all existing Standards and Recommendations originating with Committee on Power Generation.

Approved.

COMMITTEE ON WAY MATTERS:

(*a*) Consider further the Proper Foundation for Tracks in Paved Streets.

(*b*) Pavement for Use in Connection with Girder and High T-Rails. Should secure traffic counts from different companies in accordance with forms submitted in 1914 report.

(*c*) Specification with definitions for Sundry Track Materials such as Ties, Track Spikes, Bolts, Tie Rods, Tie Plates, etc. with particular reference to Physical Characteristics.

(*d*) Standard Specification for Special Work.

(*e*) Revision of Recommended Designs of Seven and Nine Inch Joint Plates with special reference to sizes of bolt holes and fits. (See *Engineering Manual* Wm 4a).

(*f*) Review all existing Standards and Recommendations originating with Committee on Way Matters.

Approved.

COMMITTEE ON HEAVY ELECTRIC TRACTION:

(*a*) Clearance Lines for Third-Rail Working Conductors. This is as follows:

Clearance Lines for Third-Rail Working Conductors; being a further joint study with the various other Railway Associations of the equipment clearance line shown on the third-rail equipment diagram adopted by this

Association at the 1912 Convention between the points FE and the gauge line of the nearest running rail and the location of the third-rail clearance line between point ET and the gauge line of the nearest running rail.

(*b*) Study of Modern Electric Locomotives.

(*c*) For further consideration of definition of Third-Rail Gauge. With reference to question: Should there be a definition of the term "Gauge Line of Third-Rail" to go with the above?

(*d*) Protection of Contact Rail where an exposed Third-Rail is used in rapid transit operation.

(*e*) Review all existing Standards and Recommendations originating with Committee on Heavy Electric Traction.

Approved.

COMMITTEE ON STANDARDS:

(a) Determine what roads are using our Standards and Recommendations.

(b) Draft style for make-up of Specifications.

Approved.

NATIONAL JOINT COMMITTEE ON OVERHEAD AND UNDERGROUND LINE CONSTRUCTION

Mr. G. W. Palmer, Jr., then reported the organization of the National Joint Committee on Overhead and Underground Line Construction and requested the approval of the Executive Committee of the action taken.

Mr. Palmer stated that in response to the invitation which had been sent out by President Black, representatives were in attendance at the first meeting, held on September 30, 1914, from the American Electric Railway Engineering Association, the American Railway Engineering Association, the American Institute of Electrical Engineers and the National Electric Light Association. At this meeting the Committee felt, in order that the work before the Committee might be properly considered and the interests of all concerned properly safeguarded, that the membership of the Committee should be considerably enlarged. The Committee as then constituted was not representative of all interests concerned, and other bodies not included in the original committee should be invited to designate representatives. This matter of additional representation is still under discussion and will come before another meeting of the Committee to be held November 17th.

There being no further business the meeting adjourned.

Respectfully submitted,

E. B. BURRITT,
Secretary.

Approved,

L. P. CRECELIUS,
President.

LETTER BALLOTS

A question having arisen as to the application of one of the subjects assigned the Joint Committee on Engineering-Accounting, President Crecelius instructed that the matter be referred to the Executive Committee for a vote by letter ballot. Accordingly, the following letter giving the matter in detail, was sent to all members.

MARCH 4, 1915.

Members Executive Committee:

GENTLEMEN.— I have been instructed by President Crecelius to present the following for your consideration.

At the meeting of the Executive Committee of the Engineering Association, held in New York on November 10, 1914, there was assigned for investigation by the Joint Committee on Engineering-Accounting as Subject (c)—

"Development of a proper ledger looking towards the maintenance of a continuous inventory."

Mr. Charles Rufus Harte, the co-chairman of the Engineering branch of this Joint Committee raises the question as to whether or not this subject applies to stock materials only or to the entire property. I quote you the following from Mr. Harte's letter:

> At the meeting of the Joint Committee on Engineering-Accounting we raised, as you recall, the question as to whether the continuous inventory applied to stock materials alone or to the entire property, and it was our understanding that the earlier correspondence indicated that Mr. J. D. Mortimer had in mind entire property.
>
> It appeared, however, in taking up this matter in Committee that previous years the Executive Committee have not looked kindly upon any action whatsoever that might give color to a belief that physical value is a factor in rate making and that certain members of the committee in the past had felt that such a procedure as this inventory would give such color.
>
> It seemed advisable, therefore, to ask you to raise the question with the Executive Committee whether or not it desired this continuous inventory referred to assignment (c) to cover the field of the entire property, or to be restricted to stock materials.
>
> The committee will address itself particularly to the latter phase of the question now and we will appreciate as early advice as may be convenient in order that provision may be made to meet the Executive Committee's wishes in detail.

I also quote you the following extract from the letter from President Crecelius:

> In regard to this, my views are that it is intended to cover the entire physical property of electric railways, and therefore the subject is a very important one, and if it were limited to stock materials only, it would not be worth the time and attention nor the expense required to have it considered before any of our committees.

An early expression of your opinion on this question would be appreciated, in order that proper instructions may be issued to Co-Chairman Harte.

Yours very truly,

E. B. BURRITT,
Secretary.

In response to this letter, the Executive Committee voted that the Joint Committee on Engineering-Accounting should consider this subject as applying to the entire physical property and should not be restricted to stock materials.

The Executive Committee of the American Association having approved the publication to the membership of a proposed amendment to the Constitution and By-Laws of that Association, providing for a reduction in the amount of dues paid by Company Section Members, from $5.00 to $2.00, it was desirable that the Constitution of the Engineering Association be amended to conform.

Accordingly, by direction of President Crecelius, the members of

the Executive Committee were requested, under date of August 18, 1915, to indicate their approval or disapproval by letter of an amendment to the Constitution of the Engineering Association by the addition of the following paragraph to Article III:

> (c) Company Section Members, consisting of Company Section Members of the American Electric Railway Association who may elect to ally themselves with this Association.

In response to this request the Committee approved the amendment.

Respectfully submitted,

E. B. BURRITT,
Secretary.

Approved,

L. P. CRECELIUS,
President.

MEETING OF OCTOBER 2, 1915

The second meeting was called to order at the Association's Headquarters, Native Sons of the Golden West Building, San Francisco. Cal., Saturday, October 2, 1915, at 11:15 a. m.

There were present: Messrs. L. P. Crecelius, *President;* John Lindall, *First Vice-President,* W. G. Gove, Member of the Executive Committee, and E. B. Burritt, *Secretary.*

Letters of regret at their inability to be present were read from *Second Vice-President* B. F. Wood, *Third Vice-President* F. R. Phillips, and also from H. F. Merker, J. P. Barnes, and G. W. Palmer, Jr., Members of the Executive Committee.

On motion, the minutes of the previous meeting were approved.

The Secretary then presented the following reports:

Report of the Executive Committee,

Report of Secretary-Treasurer,

There was then presented the Report of the Committee on Membership of Purchasing Agents.

REPORT OF COMMITTEE ON MEMBERSHIP OF PURCHASING AGENTS

To the Executive Committee of the American Electric Railway Engineering Association:

GENTLEMEN.— In pursuance with action of the Executive Committee, the undersigned were appointed by the President to "investigate and report upon the best method of handling the membership of Purchasing Agents and Storekeepers in the Association, submitting an estimate of the probable income and expense involved in the operation of any plan submitted, the Committee also to report upon the number of Purchasing Agents and Storekeepers who have allied themselves with any of the affiliated associations."

Your Committee was of the opinion that the subjects assigned for consideration could be satisfactorily handled by mail without the necessity of a meeting and have reached through that channel the following conclusions.

First. The Engineering Association seems to be unquestionably the most suitable of the existing allied Associations for the membership of

Purchasing Agent sand Storekeepers, and investigation shows that nearly all such officers who are individual members have elected to ally themselves with that Association. The greater part of materials handled are those used in the construction, maintenance or operation of plants, and are accordingly for the use of one of the various engineering departments. Your Committee does not consider a separate association for Purchasing Agents or Storekeepers either necessary or advisable at the present time.

Second. It is recommended that future presidents and executive committees give careful consideration of the advisability of placing one or more men experienced and skilled in the duties of a purchasing agent or storekeeper on such of the various standing committees as may seem desirable. This action will, in your Committees opinion, not only serve to increase the interest of those officers in the Association's work, but will increase the value of the standing committee's work by bringing to its consideration a viewpoint which is a very vital part of engineering work and which has been frequently slighted in the past.

Third. Your Committee would also suggest that in preparing the Convention program arrangements be made for one meeting of an hour or more duration, for purchasing and storekeeping officers alone. This meeting would probably not be a large one and could be held at a smaller meeting place than would be required for the allied associations, and could be held concurrently with them if preferred. This meeting would be the means of furthering the personal acquaintance of purchasing officers and would give ample opportunity for the discussion of questions pertaining solely to their work and for the submission of any additional recommendation to the executive committee for future action in this matter.

Fourth. The program here outlined would not materially increase the expenditure of the Engineering Association, but by increasing the interest of Association work for purchasing agents and storekeepers might increase the revenue from the individual membership.

Fifth. There are at present enrolled as individual members, allied with the Engineering Association, 28 purchasing agents and storekeepers, and seven with other allied associations.

Respectfully submitted,

E. E. Stigall,
F. R. Phillips,
R. W. Crowell,
J. H. Hanna, *Chairman.*
Committee on Membership of Purchasing Agents in Engineering Association.

The next report for presentation was that of the Sub-Committee on Standards dealing with the use of Standards by Member Companies.

Use of Standards by Member Companies

To the Executive Committee of the American Electric Railway Engineering Association:

Gentlemen.— Acting under your instructions the Committee on Standards has made an investigation as to the use of the various Standards and Recommendations of the Association by its Member Companies.

A data sheet was sent out by the Secretary, listing all Standards and Recommendations which have been formally adopted by the

Association and requesting information as to their use or non-use with reasons therefor. Replies were received from twenty-eight companies, classified as follows:

Companies operating 400 or more cars	9
Companies operating 100 to 400 cars	6
Companies operating less than 100 cars	13

The following table gives a classification of the various replies on the fifty-one subjects now adopted, arranged according to the originating committees.

SUMMARY

Committee Originating	Number standards	Number affirmative replies	Percentage		Number negative replies	Number "No answer" replies	Totals
			Total answers	Definite answers			
			(*Per cent*)	(*Per cent*)			
Power distribution	14	108	28	44	136	148	392
Equipment	17	119	25	39	185	172	476
Block signals	6	16	10	30	41	111	168
Heavy electric traction	2	2	4	10	19	35	56
Way matters	12	67	19	38	111	158	344
Totals	51	312	22	39	492	624	1,436

Of the 804 definite replies, 312 or 39 per cent are in the affirmative, which is not an unsatisfactory showing when it is considered that the recent adoption of many of our standards operates against their general use at the present time, and that the restrictions of commissions or municipal engineers are a potent factor against their use in many cases.

The replies represent a very small proportion of the Association's membership and are consequently not at all satisfactory as a measure of the standards in use. They probably show a higher percentage of use than would more complete reports.

Your Committee is of the opinion that the Member Companies would greatly benefit by a much more general use of this material, which has been derived in each case by hard, painstaking work of the various standing committees, and is of the opinion that the lack of use is in large measure due to lack of familiarity on the part of executive and engineering officers of the Member Companies. It is therefore recommended, that;

First. The matter be brought to the attention of the Executive Committee of the American Association with the aim of interesting through them the executives of our Member Companies;

Second. That publicity by given the Standards now available through AERA and through the personal efforts of our members;

Third. That further effort be made to get accurate information regarding the present use of our Standards and Recommendations and that a list of manufacturers who stand ready to furnish material in accordance with the Association's standards, be prepared and published.

Respectfully submitted,

J. H. HANNA.

These reports were approved by the members present and letters from Second Vice-President Wood, Third Vice-President F. R. Phillips and Messrs. Merker and Barnes, of the Executive Committee, approving these reports were read.

On motion, the Committee approved the application of 459 new members received since October 1, 1914.

On motion, the reports of the standing committees were received and approved for presentation to the Convention.

The Committee voted to formally approve the result of the letter ballot taken on the proposed amendment to the Constitution of the Engineering Association by the addition of the following paragraph to Article 3:

(c) Company Section Members, consisting of Company Section Members of the American Electric Railway Association who may elect to ally themselves with this Association.

The Executive Committee, during March, 1915, voted by letter ballot that subject "*c*", the development of a proper ledger, looking towards the maintenance of a continuous inventory, as assigned to the Committee on Engineering-Accounting, should apply to entire property. The result of this ballot was approved.

On motion by Mr. Lindall, the President was instructed to request the Executive Committee of the American Association to reconsider its decision, as a result of which the Committee on Engineering-Accounting was instructed to consider this subject as applying to stock materials only, and to recommend that the subject be reassigned to include entire property.

Mr. Gove introduced the recommendation of the Committee on Equipment as to a standard specification for quenched and tempered carbon steel shafts, axles and similar forgings. This was discussed at some length.

The request of Mr. H. T. Potter, Sales Manager of the Wyoming Shovel Works, that a paper be presented to the 1915 Convention on the subject of Track Tools was then taken up. In view of the fact that the program had been completed and that there would not be time for the presentation of further papers, it was decided that this subject should be referred to the incoming Committee on Subjects.

On motion by Mr. Gove it was voted to recommend to the incoming Executive Committee that it consider the matter of devising ways and means for bringing the Standards and Recommendations of the Engineering Association into more general use and that a special committee be appointed for this purpose. It was further recommended that this special committee investigate and report upon the extent to which reference is made to the *Engineering Manual.* In this connection, Mr. Gove stated that, in his opinion, there were many cases where the engineering officers of Member Companies did not know of the existence of the *Engineering Manual.*

On motion, it was voted that the new sections to the *Engineering Manual* should be supplied to members of the Engineering Association at cost.

On motion, the Committee passed a resolution of thanks to all committee members for their earnest coöperation in the work during the past year.

There being no further business the meeting adjourned.

Respectfully submitted,

E. B. BURRITT,
Secretary.

Approved,
L. P. CRECELIUS,
President.

PRESIDENT CRECELIUS: A motion to receive the report of the Executive Committee is now in order.

C. R. HARTE: I move that the report of the Executive Committee be received and approved.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS: The next business is the Report of the Secretary-Treasurer, which will be presented by Acting-Secretary Stocks.

ANNUAL REPORT OF THE SECRETARY-TREASURER

To the American Electric Railway Engineering Association:

GENTLEMEN: Your Secretary-Treasurer begs to submit the following report as to expenditures and membership.

The Executive Committee of the American Association appropriated $4,000 for the work of the Engineering Association during the year, and from this sum allotments were made to the various committees for their use. It will be noted that the expenditures exceed the appropriation by $559.72. This was caused largely by the expenses on account of the National Joint Committee on Overhead and Underground Line Construction, which has held numerous meetings during the year. A strict economy has been observed in the work of all committees.

The figures as to expenditures and membership are as follows:

EXPENDITURES FOR THE PERIOD OCTOBER 1, 1914, TO OCTOBER 31, 1915

Safety Code Committee	$109 40
Executive Committee	333 78
Committee on Buildings and Structures	125 74
Committee on Electrolysis	60 92
Committee on Equipment	535 01
Committee on Heavy Electric Traction	.....
Committee on Lightning Protection	221 05
Committee on Membership of Purchasing Agents	.....
Committee on Nominations	.....
Committee on Power Distribution	749 28
Committee on Power Generation	396 86
Committee on Standards	287 02
Committee on Subjects	20 85
Committee on Way Matters	856 37
Committee on Block Signals	235 75
Committee on Engineering-Accounting	68 86

National Joint Committee on Overhead and Underground Line Construction	$496 38
Committee on Transportation-Engineering	43 35
Miscellaneous	19 10
TOTAL COMMITTEE EXPENSE	$4,559 72
Engineering Manual	715 42
Proceedings	2,557 83
	$7,832 97
1914 Proceedings (accounts payable)	540 88
Total	$8,373 85

STATEMENT OF MEMBERSHIP FOR PERIOD OCTOBER 1, 1914, TO OCTOBER 31, 1915

Total Membership October 1, 1914	1,871
New Members for period October 1, 1914, to October 31, 1915	541
Total	2,412
Members withdrawn, deceased or delinquent	587
Total Membership to October 31, 1915	1,825

Respectfully submitted,
E. B. BURRITT,
Secretary-Treasurer.

PRESIDENT CRECELIUS: You have heard the report of the Secretary-Treasurer. What is your pleasure?

C. R. HARTE: I move that the report be accepted and approved. (Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS: The next order of business is the appointment of the Committee on Resolutions. I appoint C. R. Harte and E. J. Blair as members.

The next business on our program is the Report of the Committee on Lightning Protection, but before calling for the presentation of this report, I desire to state that these reports of our committees were sent out to our members about the first of September, so that the members have had them for some considerable time. It will suffice for the purpose of our meetings, therefore, to simply have a short introductory abstract to place the matter before the meeting. In the absence of the Chairman of the Committee, Mr. D. E. Crouse, the report will be presented by Mr. E. J. Blair, a member of the Committee.

E. J. BLAIR: I regret that Mr. Crouse could not be here to present the report, as being Chairman of the Committee he is naturally the more competent.

Mr. Blair then presented the report and in connection therewith said, at various points during the presentation:

We have been very much in favor of the double connection. We thought at first of suggesting a resistance but the resist-

ance to do that work would be very hard to build, and hard to maintain. The air gap can be made, in fact I saw one that would fill the bill very well, and I am sure that if some of us make inquiries a suitable air gap surely will be produced.

REPORT OF THE COMMITTEE ON LIGHTNING PROTECTION

To The American Electric Railway Engineering Association:

GENTLEMEN.— The Committee on Lightning Protection was appointed in December, 1914, and received the following instructions from the Executive Committee:

Consider the subject of Lightning Protection in its relation to Car and Line Equipment.

The first meeting was held in Pittsburgh on March 24, 1915. The members present were: Messrs. E. J. Blair, J. Leisenring, F. R. Phillips, and D. E. Crouse, *Chairman.*

During part of the day Mr. G. C. Hecker, of The Pittsburgh Railways Co., represented Mr. Phillips.

The Subjects assigned were as follows:

CARS

1. Choke Coils — Location, size, and material of core.

1-a. Lightning Arresters — Types available and location, also a suitable inspection method and period.

2. Car Wiring — With the view of preventing Electrostatic and Electromagnetic Induction.

2-a. Lightning Arrester Grounding — Size of wire, proximity to other wires and effect of steel cars on method of grounding.

LINE

3. Lightning Arresters — Types available and recommended number per mile.

4. Arrester Ground Connection — Regarding rail connection, earth connection, or both.

The development of the above subjects was carried on by the following Sub-Chairmen, assisted by the full Committee:

Subjects 1 and 1-a, F. R. Phillips.
Subjects 2 and 2-a, D. E. Crouse.
Subject 3. J. Leisenring.
Subject 4. E. J. Blair.

A Sub-Committee meeting was held in New York on May 1, 1915, Messrs. Blair and Crouse in attendance. The final committee meeting was held in Pittsburgh on June 10, 1915, with full membership in attendance.

The American Electric Railway Engineering Association has in the past considered the subject of Lightning Protection to some extent through its Committees on Equipment and Power Distribution. The

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Committee on Equipment of last year appointed a sub-committee to study lightning protection of car equipments. Their efforts were rewarded by receiving a very comprehensive list of answers to data sheets from more than one hundred member companies. This information has been available to your Special Committee on Lightning Protection.

At the 1914 Convention at Atlantic City, the discussion revealed a wide difference of opinion between the various Committees as to the desirability of earth grounding the rail, and the consequent need of harmonizing these views was responsible for the appointment of your Special Committee.

Your Committee has given prime importance to Subject 4, in the hope that it might amalgamate these interests. Careful consideration was given to the views of the Committees on Electrolysis, Power Distribution, Equipment, and Block Signals, also a special effort was made to anticipate the objections of the block signal manufacturers.

CHOKE COILS AND LIGHTNING ARRESTERS FOR CAR EQUIPMENTS

There are five groups of Lightning Arresters offered for use on car equipment and several types of each group. A short description of each group is given below.

Multipath Spark Gap Type

This arrester is made of pressed block of suitable design consisting of carborundum or other compositions which provide a multiplicity of paths or small gaps. The characteristics of these compositions are that they offer a path of high resistance to ordinary voltages but offer a path of relatively low resistance to high voltage high frequency current. The types of arresters included in this group are supplied with external spark gap as additional protection against the flow of line current.

Resistor Rod — Spark Gap — Magnetic Type

There are a large number of designs of this type of arrester. The principle characteristics consist of a composition resistor rod in series with a spark gap. A magnetic blow out circuit is provided to interrupt the flow of line current following static discharges.

Resistor Rod — Spark Gap — Mechanical Circuit Breaker Type

The characteristic of this type of arrester differs from the above mentioned only to the extent that a mechanical circuit breaker or moving arm is provided to assist in interrupting the flow of line current.

Condenser Type With a Shunted Resistance and Series Spark Gap

This type consists of a condenser of tubular form around which is shunted a wire wound high resistance, the purpose of which being to keep the condenser discharged, permitting its full capacity to be always available. A spark gap is placed in series with the condenser

element and resistance. This arrester is built upon the theory that with high frequency surges, the condenser acts practically as a short circuit, at the same time prohibiting the flow of line current between line and ground.

Electrolytic Type

This arrester is constructed of a group of aluminum trays submerged in an electrolyte which produces a film over the trays offering sufficient resistance to the flow of line current. The action of which effectively arrests the flow of line current but offers practically no resistance to high voltage. In series with the cells or trays which make up this arrester is placed a high amperage fuse as a protection to the arrester itself.

Great care should be given to the selection of a proper location for whatever type may be decided upon, and we feel sure that any of the above types may give reasonably satisfactory service. Attention should be given to the method of connecting the arrester, and a definite schedule or program for the inspection and testing of arrester should be adopted to insure the proper operation of the device.

One of the large railways operating on 600 volts in a district where electrical storms are frequent and severe has obtained satisfactory results with the use of one of the most inexpensive type of arrester on the market.

However, these results were not obtained until an exhaustive study had been made to determine the proper location of the arrester and a suitable and effective system of inspection adopted.

The Company referred to has located the arrester immediately after the trolley stand connection and just before a choke coil made up of the trolley lead running from the trolley stand to the circuit breaker, the wire being wound on a wooded core with a mean diameter of 5 in., having ten turns. The positive connection of the arrester is attached to the trolley stand terminal; the negative lead being carried to a negative bus wire running underneath the car. Both leads are kept as remote from steel and wire as is practically possible, and all connections carefully soldered.

During the Winter, the arresters are removed from all cars and taken into the shops and given a thorough inspection and tested to determine the voltage at which the arrester will flash over. The requirements being that it must flash over at 2000 volts or under but not under 1000 volts, and preferably at 1200 volts.

In the case of cars having two trolley poles one arrester is provided at each trolley.

In the event of an electrical storm, all arresters which may come within the influence of this storm are again removed and sent to the inspection shops for an examination and tested, immediately being replaced by others carried in stock.

This arrangement, of course, involves having on hand a large number of additional arresters, but it provides assurance that the protective devices are always in good order.

RECOMMENDATIONS

For equipment purposes it is recommended:

First. That the choke coil should be made of at least ten turns of wire wound on a wooden core, with a mean diameter of 5 in.

Second. That the lightning arrester, of whatever type, and choke coil be located as near the trolley base as practicable.

Third. That the leads to the arrester shall not be less than No. 6 (26,250 c. m.) wire, the connections being mechanically strong and then soldered.

Fourth. That a system of inspection be adopted which will provide ample assurance that the lightning arrester is constantly in good order.

Fifth. That the flash over point of the arrester be set at a voltage as close to the maximum operating voltage of the system as may be practicable.

CAR WIRING, WITH VIEW TO PREVENTING ELECTROSTATIC AND ELECTROMAGNETIC INDUCTION

As far as the information of your Committee shows there has not been sufficient attention given to car wiring from the standpoint of lightning protection.

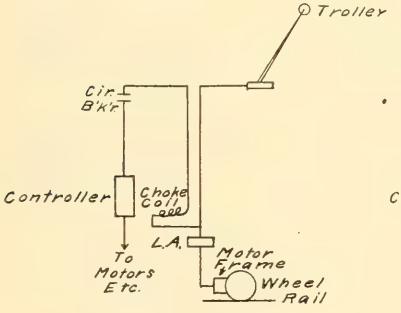


FIG. 1.

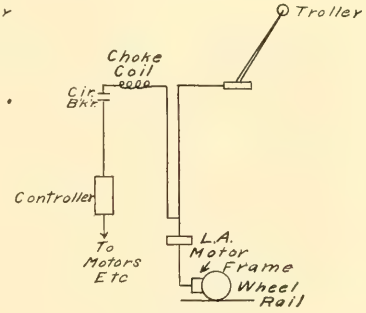


FIG. 2

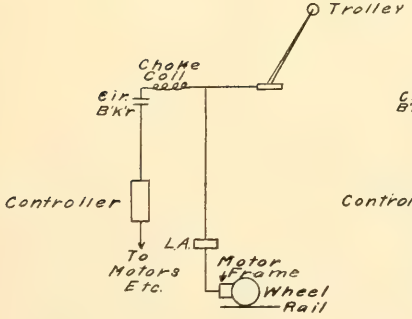


FIG. 3

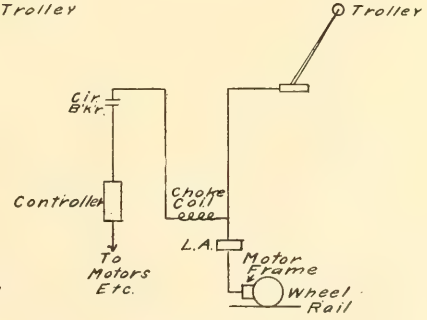


FIG. 4

Car wiring may very easily be arranged in such a manner as to jeopardize the equipment in spite of the most efficient lightning arrester. The most common instance of this objectionable condition is the placing of the trolley bus wire and ground wire in the same cable with the controller wires. With cables so arranged a lightning discharge may be induced from the bus wire directly into the controller wires and thus by-pass the lightning arrester entirely. For the above induction to be electromagnetic there must be a current flow in at least one circuit. In other words the bus line must have a ground connection of some sort other than that usually offered by the customary path of dynamic flow.

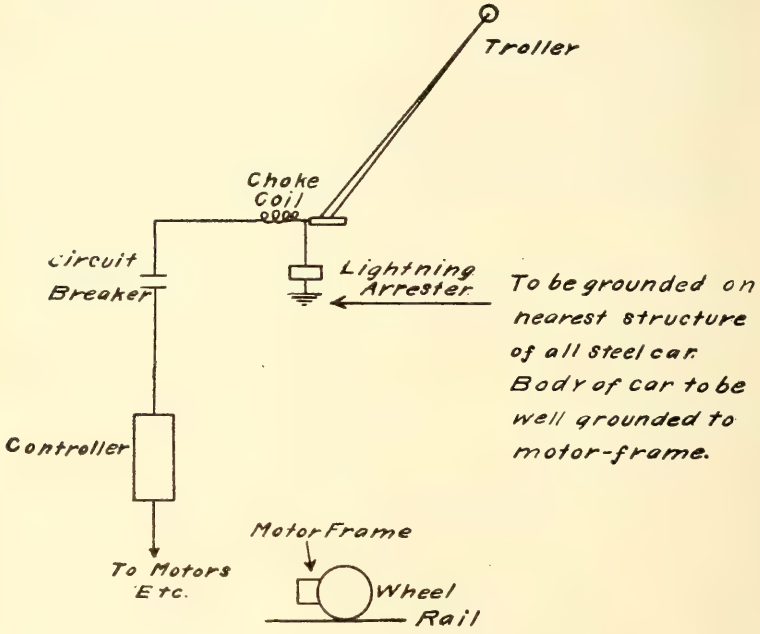


FIG. 5.

A trolley cable brought down from the roof to a lightning arrester, located under the car, and doubled directly back on itself to a circuit breaker or other apparatus would greatly aggravate induction.

Several forms of proper and improper car wiring are illustrated by the following cuts; they are shown in the order of their increasing efficiency as to the prevention of both electromagnetic and electrostatic induction. Fig. 5, being by far the most effective arrangement. In Fig. 1, the choke coil is shunted out of full effectiveness by induction in the parallel wires leading into and away from it. Moving the choke

coil out of the parallel wires, as shown in Fig. 2, makes the arrangement a little better. Fig. 3, is more efficient; although the length of wire in the arrester circuit introduces undesirable induction. This, however could be compensated by a larger choke coil. Fig. 4, is a very desirable arrangement since the wires leading to and from choke coil are widely spaced. In Fig. 5, the best conditions are met since the grounding to the steel roof frame permits arrester to be placed on top of car with the minimum length of wire in the arrester circuit.

Recommendations

Your Committee recommends the following as best practice in car wiring:

First. Avoid any connection which permits the lightning current to closely parallel controller cables.

Second. Avoid placing a wire, which carries lightning current, near and parallel for any considerable length to a wire where damage can be done by an induced charge.

Third. Avoid carrying a lightning arrester connection, which extends from the roof of a car, to an arrester situated near the floor of the car directly back on itself to the top of the car to a circuit breaker or other connection to the apparatus.

Fourth. Never bring wires connected to the opposite terminals of a lightning choke coil within twelve inches of each other.

LIGHTNING ARRESTER GROUNDING; SIZE OF WIRE, PROXIMITY TO OTHER WIRES, AND EFFECT OF STEEL CARS ON METHOD OF GROUNDING

The following questions were mailed and answers thereto received by last year's Committee on Equipment. As they are in close relationship to the above subject, they are noted here with comment on their direct bearing on method of grounding lightning arresters:

1. *Question:* Where are Lightning Arresters located on cars?
   Answer: On roof, by six Companies.
   Under floor, by ninety-one Companies.
   In car, by eight Companies.
2. *Question:* What is the size of the arrester ground wires?
   Answer: Answers range from No. 14 to No. 0 solid. The average size being No. 6.
3. *Question:* Is it separate from other ground wires?
   Answer: Yes, by ninety-three Companies.
   No, by twelve Companies.
4. *Question:* Are Lightning Arrester wires in conduits?
   Answer: No, by ninety-six Companies.
   Yes, by twelve Companies.
5. *Question:* Are all joints in Lightning Arrester circuit soldered?
   Answer: Yes, by one hundred two Companies.
   No, by eight Companies.

It would seem that with the view of preventing induction, the proper location for the car arrester would be on the roof. The roof location eliminates the necessity for following the bad practice of placing conduit on the wire leading to the arrester. As illustrated in Fig. 5, under the previous subject, the placing of the arrester on the roof does away with many possible chances of induction, and if the car be "All Steel" construction, permits grounding direct to the roof frame with a minimum amount of wire in the arrester circuit. Should the car be of wooden construction, it would still seem better to locate the arrester on the roof and use a larger choke coil to offset the greater length of wire in circuit.

The minimum size wire to be used in the arrester ground circuit to insure a rugged connection and also to have sufficient amperage capacity for any arrester, should be No. 6.

All connections in the arrester circuit should be well soldered; the wire leading to or grounding the arrester should never be in conduit. Conduit around lightning arrester wire introduces a magnetic field which has a choking effect on the passage of lightning current. The wire leading to and the ground wire from the arrester should be as short as possible; should not have any sharp bends or corners and when it can be avoided should not be run adjacent to any magnetic material.

When a car is of steel construction the ground wire should be connected to that part of the frame nearest the lightning arrester. It is true that steel provides a high resistance path compared with copper, and that it is also objectionable from a magnetic standpoint, but in a case like this the discharge current spreads out over such a large area and passes to the ground through such a large cross-section of material that these objections become practically negligible and are usually less than those encountered when the whole discharge is concentrated in some copper wire which is located for a considerable distance close to the steel structure of a car.

Recommendations

Your Committee recommends the following as best practice in car wiring:

First. The size of wire used in lightning arrester ground should be not less than No. 6 copper.

Second. The ground wire should be separate from other car ground wires and should be as short and straight as possible.

Third. Wires in the lightning arrester circuit should not be run in conduits, and when it is possible to avoid it they should not be run adjacent to magnetic material.

Fourth. All wires in lightning arrester circuit should have their connections well soldered.

Fifth. When steel cars are used the lightning arrester ground should be connected to the nearest steel structure, after the fact has been

established that this point of connection has intimate and continuous contact through the steel framing of car and ground connection (as shown in Fig. 6) to the motor frame.

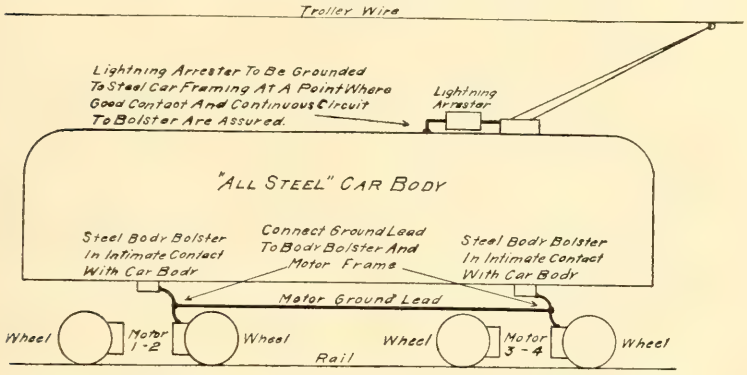

Troller Wire
Lightning Arrester To Be Grounded To Steel Car Framing At A Point Where Good Contact And Continuous Circuit To Bolster Are Assured.
Lightning Arrester
"ALL STEEL" CAR BODY
Steel Body Bolster In Intimate Contact With Car Body
Connect Ground Lead To Body Bolster And Motor Frame
Steel Body Bolster In Intimate Contact With Car Body
Motor Ground Lead
Wheel
Motor 1-2
Wheel
Wheel
Motor 3-4
Wheel
Rail

FIG. 6.— METHOD OF GROUNDING ARRESTER ON STEEL CAR BODY.

LINE LIGHTNING ARRESTERS

The use of Line Lightning Arresters is, without doubt, of the utmost importance if a maximum of insurance against equipment and station damage by lightning is to be obtained. It is true that lightning arresters can be installed on the car and in stations, and a certain percentage of protection secured, but without those on the line also, a loophole is left, which may largely offset the benefits obtained from those used elsewhere, and cost a company large sums in the course of a season's storms. The data sheets collected by last year's Committee on Equipment show answers as follows:—

Question 24: Is the lightning protection of your feeder and line system laid out with the view to protect equipment as well as the power house?

Answer: Yes, by eighty-one railroads.
No, by sixteen railroads.

Question 25: To what extent does lightning protection of feeder and line obviate lightning troubles on car equipment?

Answer: Five railroads have reduced equipment troubles 100 per cent.
Two railroads have reduced equipment troubles 95 per cent.
Four railroads have reduced equipment troubles 90 per cent.
One railroad has reduced equipment troubles 75 per cent.
Two railroads have reduced equipment troubles 50 per cent.

One railroad has reduced equipment troubles 45 per cent.

One railroad has reduced cases of trouble in one year from 150 to 46.

Fifty-nine railroads report that protection of line aids materially in protection of car equipment.

Four railroads report that they see no additional advantage to car equipments with line protected.

As will be noted the above answers argue strongly for line protection.

Line lightning arresters are usually mounted on the pole or bridge supporting the trolley or feeder wires and are as a rule placed, as near as possible to the point at which the trolley and feeder are tied together, commonly called feeder taps. The number of taps varies considerably on different systems in accordance with the voltage, load, size of feeder, etc., and the number of arresters used in a given length of track may vary also, not for the same reasons that the taps vary, but because of other local conditions, such, for instance, as the severity of lightning disturbances in a particular locality.

The type of arrester, the number used on a given unit length of track and the method of installing them, is fundamentally dependent upon the value of the apparatus protected, the requirements as to the continuity of service and the safety factor and type of insulation maintained as compared with the cost of the arresters and their proper maintenance. The number of arresters required and their distribution along the line is a problem which requires considerable study and definite knowledge of each particular line, and its lightning conditions covering a period of years. As a general rule railway companies have not given the subject a great deal of study and are satisfied to standardize on a definite number of arresters per mile. At the present time this practice varies in different localities from two to seven arresters per mile, probably the greatest number of installations being made with five per mile, and under ordinary conditions, this should give very satisfactory results.

Description of Types

There are two general classes of line arresters, those with an air gap and those without. In the first type no current flows through the arrester except at the time of a line disturbance of sufficient severity to build up the voltage on the protected wire to a point which will break down the air gap and discharge to ground. In the second type there is a continual small flow of dynamic current, used either to build up a resisting film on certain elements in the arrester, or for other purposes.

With the air gap type of arrester it is necessary to provide some means for breaking the flow of dynamic current which occurs after

the air gap has been broken down by the static discharge. This has been accomplished by the manufacturers in various ways.

One widely used arrester is equipped with an adjustable air gap of about 0.025 in., a low series resistance, and a blowout coil into which a part of the current is shunted at the time of a discharge. This produces a strong magnetic field across the spark gap which blows out the discharge arc and restores the conditions to those existing before the discharge occurred.

Another well-known arrester employs a different method of breaking the flow of line current to ground, its principle being that of the circuit breaker. In this arrester an air gap and series resistance is used as in that described above, but instead of shunting a part of the dynamic current into a blow out coil, it is by passed into the winding of a solenoid magnet, the armature of which is in the path to ground. This armature, in its normal position, closes the circuit by gravity. At the time of discharge the coil is energized, the armature is raised and the circuit opened, the breaking of the arc, due to raising the armature, restores the arrester automatically to its normal position, the armature reseating itself by gravity.

A somewhat newer type of arrester, is composed of a spark gap, tubular condenser, and resistance. The condenser is shunted by the high resistance which tends to keep the condenser discharged under normal conditions. The static discharge bridges the spark gap and passes through the condenser which acts practically as a short circuit to ground the high frequency disturbance.

The principal type of arrester that does not provide an air gap in the circuit to ground is the electrolytic type, which acts on the same principle as the arrester for higher voltages, as used in transmission lines at power plants.

The electrolytic arrester depends on a small leakage current keeping a film formed on an aluminum plate at the normal voltage. The leakage current is very small, but upon sudden rise in potential a current flow through the arrester, which is of low internal resistance, relieves the excessive pressure. This type of arrester is not, at present, especially recommended for line work, due to the difficulty of mounting and cost of inspection and maintenance.

Conclusions

In conclusion it should be point out:—

First, that any arrester, for use in line service should be compact, rugged and mounted in a well made weather-proof box. It should also be so designed that an inspection of all parts is easily feasible.

Second, that protection afforded by arresters on overhead lines is as important to the safety of car equipments as it is to the trolley wires and stations.

Third, that an arrester which is to be placed in service for line protection should have as an inherent quality a positive ability to disrupt or prevent the dynamic arc. Any failure in this respect would result in a short circuit which, owing to its possible remoteness, might prove difficult of detection.

THE GROUNDING OF LINE LIGHTNING ARRESTERS

The primary purpose for which your Committee was appointed is to make recommendations as to the grounding of line lightning arresters for 600 volt direct current railways, since the various interests have not been able to agree on the subject. Power distribution men and car equipment men have favored connecting line lightning arresters to both an earth ground and to the track rail, because of the more efficient protection secured thereby. On the other hand objections to this double connection have been made by electrolysis men and block signal men. The former state that the traction current flowing over the connection from rail to earth damages not only the earth ground itself, but also adds to the amount of current on foreign sub-surface structures, such as water pipes and the like. The objection from a block signal view point is that where double rail alternating current track circuits are used, broken rail protection is lost due to signal current shunting around the break from one lightning arrester connection to another.

Recommendations

Your Committee has given the various phases of the matter careful study and Recommends that — Line lightning arrester ground wires should be connected to a good earth ground and also to the track rail, except under the following conditions:

1. Where the current flow (see note) on the connection from track rail to earth would exceed an average of one-quarter ampere during any twenty-four hour period.

(Note:— In checking up this current flow, the algebraic sum of currents flowing firs in one direction and then in the other, shall be used in determining the current flow. It is assumed that a resultant of more than one-quarter ampere average in either direction should be avoided.)

2. Where alternating current track block signals of the double rail type are used.

Where the foregoing exceptions exist, and in order to prevent doing away with the rail connection which would be the only alternative, your Committee suggests that the connection be made from line lightning arrester to both earth ground and track rail, but that there be installed a suitably designed air gap in the circuit between the point where the rail connection joins the lightning arrester ground wire and the earth ground itself (see Fig. 7). This decreases somewhat the efficiency of lightning protection, but would at the same time prohibit the flow of any current that would tend to cause electrolytic damage

or interfere with proper signal operation. We do not doubt that an air gap suitable for this purpose can be obtained.

With reference to the second exception — namely for block signal territory, your Committee feels that under some conditions it would be perfectly safe to make the solid connection to both rail and earth without the air gap. However, we have not sufficient information

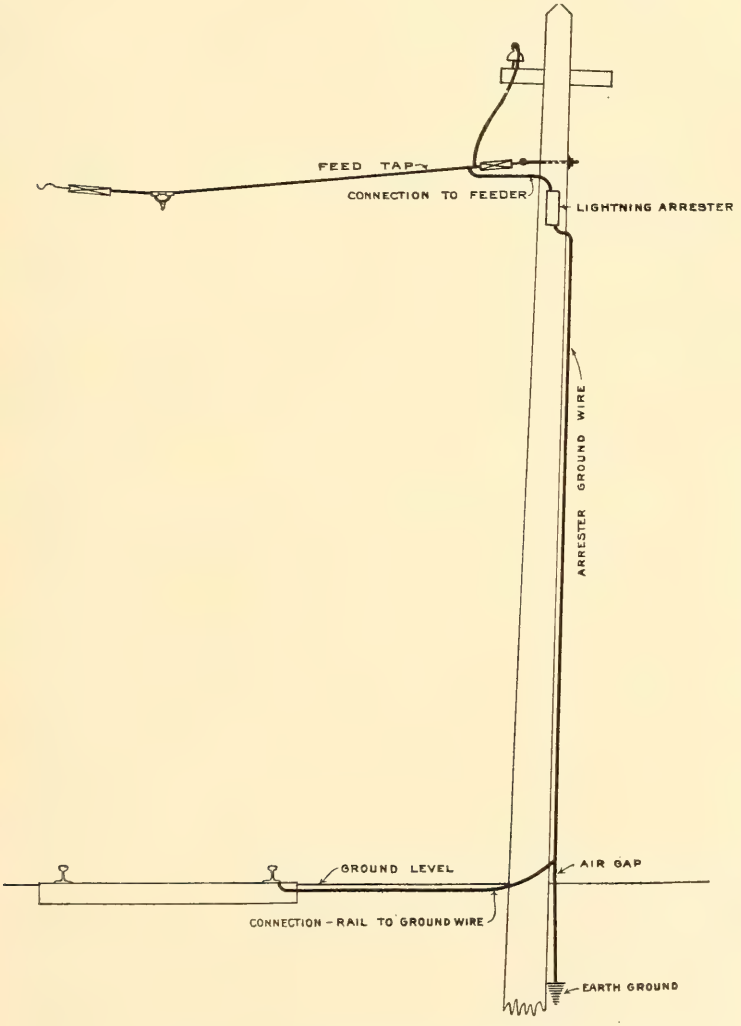


FIG. 7.— METHOD OF GROUNDING LINE LIGHTNING ARRESTER.

from the signal manufacturers to warrant any qualifications of our recommendations. We hope that ultimately it may be ascertained that for certain lengths of blocks and with certain types of signal equipment, the air gap will not be necessary.

As to exception number 1 — taking care of the electrolysis objections to the double ground: An arbitrary figure of one-quarter ampere average for any twenty-four hour period has been chosen because it was believed that even if that amount of current flows the lightning arrester ground would remain intact for a reasonable length of time. As a matter of fact, it is quite likely that this amount of current will nowhere near be reached in a great majority of cases. The additional current that would accrue to sub-surface structures, such as pipes and the like, is hardly worth consideration where a limit of one-quarter ampere for any twenty-four hour period is placed on the flow of current to or from the lightning arrester ground. In other words, if the lightning arrester ground is taken care of from an electrolysis point of view the sub-surface structures have automatically been cared for. It is hoped that member companies will be sufficiently interested in this provision for the protection against electrolysis to check up their ground connections as to current flow, etc.

In arriving at the conclusions the first thing that was considered was the proper protection of line and car equipment from lightning disturbances. Without any question the highest degree of protection is assured when the connection to both rail and earth ground is made, for several reasons.

First — Track rail and earth should be at the same potential when a static discharge takes place in order to adequately protect car equipment, and to assure these being at the same potential requires a connection from track rail to earth.

Second — Many times the rail will be a better ground than the earth ground and the double connection will furnish a multipath to ground. Then again if one connection is destroyed the other will allow the arrester to function properly.

Third — There are certain types of line lightning arresters that require the rail connection so that sufficient dynamic current will flow to operate the arrester.

The earth ground should be installed in the best manner possible so as to obtain a path to earth from line lightning arrester that is as direct and has as few turns in it as possible.

It is generally understood that proper protection from lightning disturbances depends to a large extent on the efficiency of the lightning arrester earth connection. In other words, the aim should be at all times to secure the lowest possible amount of resistance in the connection to ground. Therefore, in order to intelligently attack the problem it is necessary to have an idea of the relative proportions of the resistance of a lightning arrester earth ground and the resistance

to earth of track rails. Both of these quantities vary over a great range for different conditions. An idea of the range of the former, namely the resistance to earth of ordinary lightning arrester grounds may be obtained from the following table showing results of tests of such grounds made in the state of Iowa by Professor Shane of the State University in the year 1911, for the Iowa Electrical Association. In the tests at Ames the soil in which the arrester grounds were buried was black muck and was nearly always damp so that it will be seen that the values obtained represent minimums of resistance.

RESISTANCE TO EARTH OF LIGHTNING ARRESTER GROUNDS

	Maximum	Minimum	Mean	Relative	Relative to last year	Ratio of maximum resistance to minimum
SUMMARY OF RESULTS AT AMES						
Iron plates in earth	12.0	6.8	9.9	1.18	1.28	1.76
Iron plates in charcoal	16.8	8.3	12.8	1.54	1.55	2.02
Copper plates in earth	10.8	7.1	8.6	1.02	1.13	1.52
Copper plates in charcoal	32.0	9.9	19.6	2.34	2.31	3.24
Aluminum plates in earth	15.1	8.6	11.3	1.34	1.39	1.75
Aluminum plates in charcoal	67.0	15.8	34.8	4.15	3.96	4.25
Manufactured ground No. 1 in earth	20.6	8.8	13.0	1.55	1.73	2.34
Manufactured ground No. 1 in charcoal			Discontinued			
1.5-inch pipe in 6 ft. earth	15.5	8.8	11.6	1.38	1.45	1.76
1.5-inch pipe in 6 ft. charcoal	38.8	9.4	22.1	2.63	1.72	4.13
1.5-inch pipe in 3 ft. earth			Discontinued			
1.5-inch pipe in 10 ft. earth	11.6	6.2	8.4	1.00	1.27	1.82
1.0-inch pipe in 15 ft. earth	11.8	7.5	9.8	1.17	1.45	1.57
Manufactured ground No. 2 in earth	34.0	14.2	22.8	2.72	.....	2.40
Manufactured ground No. 2 in charcoal	35.6	11.8	19.4	2.31	.....	3.02
SUMMARY OF RESULTS AT IOWA CITY						
Manufactured ground No. 3	540.0	45.8	175.0	8.15	.....	11.8
Manufactured ground No. 1 in coke	28.9	15.6	21.5	1.00	.....	1.85
Manufactured ground No. 4	119.0	58.0	88.5	4.11	.....	2.05
¾-inch pipe in coke	236.0	34.4	118.4	5.50	.....	6.85
¾-inch pipe in 5 ft. earth	139.0	28.5	68.2	3.17	.....	4.87
Manufactured ground No. 2	185.0	43.5	99.5	4.63	.....	4.25
1.5-inch pipe in 5 ft. earth	66.0	23.1	40.8	1.90	.....	2.86

Your Committee believes that with careful methods followed for grounding and with good conditions it cannot be expected to obtain lightning arrester grounds in any part of the country with a resistance of less than 5 ohms to earth and this resistance even under good conditions may rise to as much as 50 ohms. Where conditions are not good, as will be seen from the table, resistances may go to ten times these values. Now then, it is necessary to obtain an idea of the resistance to earth of track rails. To do this, track construction is subdivided into three classes as follows:

1. Interurban and suburban track well ballasted with rock, or coarse gravel.

2. Interurban and suburban track not carefully ballasted and sometimes in intimate connection with the upper surface of soil.

3. Ordinary city track construction for street cars.

Discussing these different classes in their order, we have:

First — The rock or gravel ballasted Interurban or Suburban type; in this case it is obvious that the track rail is to a large extent, relatively speaking, insulated from the earth, except in so far as ground connections applied at the negative bus bar of the substation are concerned. Considering points along the line and for the purposes of lightning protection, this type of track is regarded as insulated.

Second — Interurban and suburban tracks not well ballasted. It would seem that in most cases this type of track is fairly well grounded when any appreciable length is considered. Sometimes the top of the ties are below the level of an adjacent highway, and one rail at least may be in very intimate connection with the upper surface of the ground. Of course the rails are not buried in permanently damp earth, but when the surface contact of say 1000 ft. of double track is considered it will be apparent that the ohmic resistance to earth is relatively low. In many instances the resistance of 1000 ft. of track to earth would doubtless be less than the resistance to earth of a single lightning arrester ground adjacent to the track. For purposes of this study such track is regarded as in the grounded class.

Third — Ordinary city track construction for street cars. There are various types of such construction, from the older methods in which the rail is laid in direct contact with the earth, and hereafter referred to as Type "4," to the more modern construction, such as Type "2", where heavy girder rail is installed on wood ties set in concrete and the rail itself protected by concrete and the whole surrounded by granite blocks with tar and sand between them. In order to obtain accurate information of the resistance of these various types it was necessary to make tests on isolated pieces of track construction in which there was no traction current flowing. Your Committee was fortunate in being able to secure the results of such tests recently made in a city of the middle west, and went into the methods and calculations of these tests sufficiently to establish their value as being the best that could anywhere be obtained.

Experimenters have established that the resistance of the earth where large masses of earth are involved is small in comparison with the resistance between a metal electrode buried in the earth and the surrounding earth material. Another method of stating this fact is, that the resistance between two electrodes buried in the earth increases in diminishing ratio as the distance between them increases, until when they are about ten feet apart the resistance becomes approximately constant

Concrete road beds do not insulate, but only increase resistance to an extent to decrease leakage currents.

The resistance of rail to earth varies greatly with the seasons, and of course with different soils. In making tests, from different pieces of rail to ground, it was of course necessary to obtain a ground electrode of the smallest resistance to the earth itself, and then correct for this small resistance. A section of 6 in. gas pipe 48 ft. long was chosen as this "ground." This pipe was buried about 25 ft. away from the rail sections, and is referred to in the test data as "G."

TEST DATA

ITEM	Type	Resistance to "G" in ohms corrected for end effect	Same per 1000 ft. of double track
4 ft. length of 129 lb. rail on steel tie set in concrete.....	1	113.6	0.113
Ditto on wood tie set in concrete	2	131.5	0.131
Ditto on wood tie set in crushed stone	3	229.2	0.229
4½-ft. length of 129-lb. rail with rail coming in direct contact with earth and typifying the older method of electric railway track construction in cities and towns.....	4	43.4	0.049

As compared with the tests of lightning arrester grounds the resistance of which are shown in the table on page 16, it is seen that the resistance of type "3", which shows the highest rail resistance per 1000 ft. of double track, is very low, or in other words, 1000 ft. of double track, type "3", would have a resistance to earth of 0.23 ohms, whereas, assuming the best lightning arrester grounds at 5 ohms, it is seen that the resistance of the lightning arrester ground is 20 times that of the track. In arriving at this result the highest resistance track and the lowest resistance lightning arrester ground has been chosen so that the minimum proportions are those stated. Therefore, your Committee has proven (to its own satisfaction) that no lightning arrester ground will be found better than the track grounds in city track construction.

From the foregoing discussion of resistance to earth of track rails it will be seen that the connection of the lightning arrester ground wire to the rails on classes of track such as 2 and 3 will be an added assurance of a good ground connection, and in many cases the rail ground will be the best one of the two. With the relative resistances in mind it will also be seen that very little current is apt to flow over the connection between rail and earth ground However, a limit on the amount to be allowed was set earlier in this report. (See p. 13.)

On the well ballasted type of track, which may be considered fairly well insulated the connection from rail to the earth ground is more necessary for lightning protection than on the other two types, but on the other hand the objections to the connection will exist more often on such construction.

METHOD OF INSTALLATION OF GROUND WIRES FOR LINE LIGHTNING ARRESTERS

The ground connection shall be of solid copper wire, not less than No. 4, securely fastened to the back of the pole, and except as noted, well bonded to track rails and either:

(a) extended as ground coil or
(b) well soldered into a ground pipe.

In any case, at least eight feet of the lower exposed portion shall have a non-metallic protection. Any change in direction of the ground wire must be made by easy curves.

Respectfully submitted,

E. J. Blair,
J. Leisenring,
F. R. Phillips,
D. E. Crouse, *Chairman,*
Committee on Lightning Protection.

President Crecelius:— This is a very important subject and has received considerable attention in the past. It is necessary to reconcile a considerable amount of difference of opinion between the chairmen of the various committees, with regard to the grounding of lightning arresters, and this report should be productive of interesting discussion.

Discussion of Report of Committee on Lightning Protection

John Lindall:— I would like to ask Mr. Blair in connection with the inspection of the car lightning arrester if he has any suggestion as to what the inspection should be on the car to insure that the arrester is in perfect condition? He has made reference to inspection which involves the taking of the arrester for tests off the car every year, but so far I have not seen any reference to the inspection which might be made during the time when the car is subjected to a general inspection, or at some definite period.

C. P. Nachod (Written Discussion):— Referring to this report a certain division of lightning arresters is made. Another independent division is into two classes: those in which the dynamic current does not follow the discharge; and those in which the dynamic current does follow, but is interrupted by some automatic action of the arrester, as by mechanical

circuit breaker, magnetic blow-out, etc.; all operated by a relatively large quantity of dynamic current. This second class, therefore, permits the trouble to happen, as it were, and then automatically interrupts it. As stated above a considerable volume of dynamic current is necessary to operate these interrupters and therefore a low resistance is necessary. Such lightning arresters can be very harmful in case of a high resistance ground, or if connected to circuits where a line intervenes having resistance on both the positive and negative ends.

As manufacturers of automatic signals we have had considerable damage caused to these signals by the installation of such a type of arresters. They will permit the dynamic current to jump the gap and establish the arc, but the interrupter will not then work owing to insufficient volume of dynamic current. Enough flows, however, to defeat the object of the arrester as a protective device, and sometimes enough to start a fire.

It seems that manufacturers of this type of arrester should state specifically in their directions that a certain volume of current is necessary for the operation of the arrester, and that it should not be connected with resistance ahead on the positive side, but should be connected to the rail to insure a low resistance return path. The type preferred for block signal circuits is the multipath spark gap.

PRESIDENT CRECELIUS:— If there is no further discussion on the report I will call on Mr. Blair to close the discussion.

E. J. BLAIR:— Mr. Lindall's question about inspection is one I must confess we rather steered clear of, although there were several different sentiments expressed. Without making any attempt to excuse the committee at all, I will say that you must bear in mind that the committee was considering in particular the subject of the earth grounding of lightning arresters, and when we came to these other points, although they take some considerable space in the report, we did not give them one-tenth of the time we gave the other subject. On the matter of inspection, we discussed what we should do in the way of putting in certain recommendations, and we found, of course, that there was some little difference of opinion on that point. Mr. Phillips, representing the Committee

on Equipment, was better posted on car arresters than any of the rest of us, and as I recall it, his opinion was that not only should periodic tests be made and the arresters taken down at such tests, but that the arresters should be tested after each and every severe lightning storm. As to the points in Mr. Nachod's discussion it seems to me that is rather more of an amplification of the discussion of types of arresters than your Committee contemplated. That is to say, in describing the various types we have not made any effort to do more than simply describe them; we have not tried to find fault with one type or the other, or praise one type or the other. With reference to Mr. Nachod's letter I would say that so far as the types of arresters with which I am familiar it is customary on the part of the manufacturers to state the amount of current necessary to operate them.

F. I. FULLER:— I will say that we do not have any lightning arresters in our cars or line arresters either, which just illustrates the difference.

PRESIDENT CRECELIUS:— We observed that on our trip, and found it to be an interesting feature.

This closes the subject, but before passing on to the next matter, the Chair would like to have a motion to receive the Report of the Committee on Lightning Protection, which has been so very well prepared and ably presented.

W. G. GOVE:— I move that the report be received and approved.

(Motion duly seconded, stated and carried.)

C. R. PHENICIE:— I do not know whether I am out of order, but this is an important subject, and I wonder if it is the intention to continue this Committee beyond this particular Convention?

PRESIDENT CRECELIUS:— The Chair would advise that the work of this Special Committee ends with the presentation of its report. This Committee was appointed to reconcile differences that crept into the recommendations of the various standing committees on the subject of grounding of lightning arresters. The Committee has done its work well, but their term of service expires with the presentation of its

report. However, the subject matter of this report will come before the standing committees for consideration and there will be provision made in the future, whereby information of this character can be kept up-to-date. It will be dealt with by other standing committees, so that the subject will not be lost sight of.

We will now take up the report of the Committee on Standards, of which committee Mr. H. H. Adams is chairman. Mr. Adams is absent and the report will be presented by Mr. W. G. Gove.

W. G. Gove:— I know every one of you will join with me in regretting that Mr. Adams is not able to be present with us at this Convention and present this report himself. Mr. Adams is always so active in the work of the Association, and so thoroughly capable of handling the important matter of the work of the Committee on Standards, that it is particularly unfortunate that he has had to remain in Chicago and could not attend this Convention.

In abstracting the report of the Committee on Standards Mr. Gove said in connection therewith:

Much of the important work of the Association is done through its committees, and a great deal of dependence must be placed upon the work and investigations made by the committees. The recommendations made by them and adopted at the conventions, as well as the specifications that have been made standard and similarly adopted should be more generally used by the various railroad companies. The matter of the adoption of the standards of the Association has been rather discouraging up-to-date, and I think a great deal of that is not only due to the fact that certain members have assumed a rather apathetic attitude towards them, but that it is also due to the fact that the proper executive officer or operating official in direct charge of the work to which the standards relate has not had his attention called to them in the proper manner, that is, at least not in a vigorous way, so as to make it plain to them that the money spent by the railroads and assigned to these various associations to carry along their committee work has resulted in certain conclusions and

results that should in turn be used by the railroad companies in order to make their investment in the work of the Association profitable. That applies to the smaller companies as well as big companies. It also applies to all of the departments of the companies, sometimes closely coördinated, and sometimes not so closely coördinated, in other words, I am quite sure if this was properly understood that a more vigorous action would be taken towards adopting and using the work of the Association.

This is the thirteenth annual meeting of this Association, and personally I cannot understand why, nor do I believe that it is possible to give a reason why — it has not been practicable to make more specific and fuller use of the Sandard Specifications as well as the various Recommendations, in the same way that the other engineering associations make use of theirs — The American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and other similar bodies — these all have their standards and the members put them into effect and use them.

I will not attempt to abstract the proposed Regulations Covering the Style of Specifications which is submitted in this report, because it is matter that must be read in order to be thoroughly understood and it is not proposed as a standard at this time. Like a great deal of the other work of the Association, much must be done in finally vamping and re-vamping it to make it satisfactory to all. The idea was to get something started in the way of a standard form for specifications, something that could be worked upon, something that would in the next few years be adopted as a Standard to follow in drafting specifications, and placed in general use by all of the companies through their purchasing departments, and in fact all of their working departments, and it is only submitted with that understanding.

REPORT OF THE COMMITTEE ON STANDARDS

To the American Electric Railway Engineering Association:

GENTLEMEN.— Your Committee on Standards, in addition to its work of approving the Standards and Recommendations of the standing committees, received from the Executive Committee instructions to investigate and report upon the following subjects:

(*a*) Determine what roads are using Association Standards and Recommendations.

(*b*) Draft style for make-up of specifications.

Your Chairman therefore appointed a Sub-committee on Style, with Mr. A. S. Richey, Chairman, and Messrs. E. R. Hill and J. H. Hanna, members.

He also appointed another committee known as the Committee on Revision of Engineering Manual, consisting of Mr. Martin Schreiber, Chairman, and Messrs. W. G. Gove and C. F. Bedwell, members.

The work of determining what companies were using Association Standards was referred to the Secretary and he issued Data Sheet No. 139, requesting member companies to indicate thereon what Standards they had in use.

MEETINGS

The Sub-committee on Style held a meeting at the Association headquarters on July 13, 1915, at which Mr. A. S. Richey, Chairman, J. H. Hanna and S. A. Spaulding (representing Mr. E. R. Hill), were present.

At this meeting a preliminary draft of style for make-up of specifications was formulated for presentation at the meeting of the whole Committee.

In accordance with the rules for the adoption of Standards as promulgated by the Executive Committee, your Committee met at the Association headquarters on July 29 and 30, 1915, to consider the recommendations of the present standing committees in their reports for the current year and also to consider other recommendations from the 1914 Convention that needed the approval of this Committee before their final adoption.

This meeting of your Committee was attended by every member, with the exception of one who was unavoidably absent.

On July 29 there were present: Mr. H. H. Adams, *Chairman*; Mr. Martin Schreiber, *Vice-Chairman*; Mr. A. S. Richey, representing the Committee on Power Distribution; Mr. J. W. Welsh, representing the Committee on Power Generation; Mr. C. S. Kimball, representing the Committee on Way Matters; W. G. Cove, representing the Committee on Equipment; C. F. Bedwell, representing Committee on Buildings and Structures; and the following members at large: Messrs. C. H. Clark, H. A. Currie, for Mr. E. B. Katté, J. H. Hanna and F. R. Phillips. In addition to the above mentioned, there were present: Messrs. A. B. Stitzer, W. E. Johnson, R. C. Cram, Prof. H. H. Norris of the *Electric Railway Journal,* and E. B. Burritt, Secretary.

At the session on July 30 there were present: Mr. H. H. Adams, *Chairman;* Mr. Martin Schreiber, *Vice-Chairman;* Mr. A. S. Richey, representing the Committee on Power Distribution; Mr. W. G. Gove, representing the Committee on Equipment; Mr. J. W. Welsh, representing the Committee on Power Generation; Mr. C. S. Kimball, representing the Committee on Way Matters; Mr. E. R. Hill, representing the Committee on Heavy Electric Traction; Mr. C. F. Bedwell, representing the Committee on Buildings and Structures, and the following members at large: Messrs. J. H. Hanna, F. R. Phillips, E. B. Katté and C. H. Clark. In addition to the above there were present: Messrs. J. M. Waldron, R. C. Cram, W. E. Johnson, Frank Kingsley of the *Electric Railway Journal,* and E. B. Burritt, Secretary.

USE OF STANDARDS BY MEMBER COMPANIES

The response to the data sheet sent out by the Secretary with a view to determining what companies are using Association Standards and Recommendations was so unsatisfactory that the Committee recommends that this matter be referred back to the Secretary and that another inquiry be addressed to member companies, preferably to the executive officer rather than to the engineering officer.

In connection with the use of Standards by member companies, the Chairman appointed Mr. J. H. Hanna a committee of one to prepare a report to the Executive Committee * informing that body of the situation as to the use of the Association's Standards and Recommendations by member companies, the report to recommend that the Association take such steps as may be advisable for furthering the use of the Standards.

PROPOSED REGULATIONS GOVERNING THE STYLE OF SPECIFICATIONS TO BE ADOPTED BY THE ASSOCIATION

In submitting these regulations, your Committee does not recommend that they be adopted by the Association as Standard until they have been tried out for a period of a year or more and suggestions have been received from the various standing committees whose work is affected. We recommend, however, that the form submitted herewith be followed by the committees in so far as practicable in the preparation of all specifications. If, after sufficient trial, these regulations, with such amendments as may be found advisable, are formally adopted by the Association, they should be embodied in the *Engineering Manual,* and specifications which have been adopted in the past should be so amended as to bring them within these regulations where practicable.

As examples of specifications which in general are constructed in accordance with the following regulations, your committee would call attention to the Association's recommended specifications, Wm 3a, Splice Bars for Girder and High T-Rails, and Wr 2c, for the Manufacture of Open Hearth Girder and High T-Rail.

*See page 15

(A) Arrangement, Lettering and Numbering

1. The material in each specification shall be grouped under sub-titles, numbered consecutively by Roman numerals. The principal divisions under a sub-title shall be designated by upper-case italic letters, in parentheses: (*A*), (*B*), (*C*), etc.

2. The sections in each specification shall be numbered continuously by Arabic numerals. Sub-divisions under a single section shall be distinguished by lower-case italics, in parentheses: (*a*), (*b*), (*c*), etc. This side lettering shall not run continuously throughout a given specification, but shall begin with (*a*) in each section.

3. The general arrangement of specifications shall be as follows:

TITLE

Matter of an introductory or general nature (see Section 4, below).

1. SUB-TITLE.

(*A*) principal divisions under a sub-title:

1. Sections (numbers to run consecutively throughout the specifications).

(*a*) Sub-divisions of a section (letters to run consecutively throughout a section only).

(*B*) form and sequence of sub-titles:

4. Directly after the title of the specification insert sections of an introductory descriptive or general character, stating definitely the material, apparatus or work which the specification is designed to cover. No sub-title shall be used for such matter.

5. The matter following these opening sections (if any) shall be grouped in general under the following sub-titles in the sequence indicated:

I. Definition of Terms

6. If a specification contains numerous terms that admit of ambiguity, they shall be defined under this sub-title. If, on the other hand, a specification contains only a few such terms, they shall preferably be defined where they are first used. The definition of the same term in different specifications shall, if possible, be identical. Standard Terminology of the Association shall be used where applicable.

7. The word "Company", where occurring in a specification, shall mean the purchaser of the material or his duly authorized representative. The word "Contractor", where occurring in a specification, shall mean the party accepting the order to furnish the material or to do the work included in the specification, or his duly authorized representative.

II. Manufacture

III. Chemical Properties and Tests

IV. Physical Properties and Tests

(*A*) Mechanical

(*B*) Electrical

(*C*) Magnetic
(*D*) Thermal
(*E*) Other properties and tests under appropriately descriptive headings

Under III and IV the method of sampling and the standard test specimens shall be defined.

V. Designs, Drawings, Dimensions, Weights, Gauges, Etc.

8. This sub-title is to be used in a form appropriate to the matter to which it refers and shall be followed immediately by appropriate sections covering "permissible variations." If the matter under "permissible variations" is lengthy and contains numerous sections, an appropriate special sub-title shall be used. Under Sub-title V should be given a list of all drawings, whether furnished by the contractor or by the company, which apply directly to or are a part of the specification.

VI. Workmanship and Finish

9. Sections under this sub-title should include detailed specifications for all construction work embodied in the specification, as well as the requirements for workmanship and finish on material furnished.

VII. Packing, Marking, and Shipping

10. If the sections under Sub-title VII are limited in a given specification to only one or two of the above three items, the sub-title shall be abridged accordingly.

VIII. Inspection, Rejection and Guarantee

IX. Special Sub-titles

11. Sections that cannot be appropriately placed under any of the above sub-titles shall be grouped under special sub-titles, inserted in their most logical position. Such special sub-titles shall be indicative of the contents of the sections to which they pertain. The use of sub-titles such as "General", "Miscellaneous" etc., shall be avoided.

X. Index

12. In so far as the above sub-titles are used, the sequence in which they are given above shall, if possible, be adhered to.

(*C*) headings:

13. Every numbered section shall have a heading in distinctive type, briefly indicative of its contents.

14. The sequence of matter under a given sub-title shall be left to the judgment of the committee concerned. In so far as possible the same sequence of headings shall be observed in different specifications prepared by a given committee. The requirements for specifications

prepared by different committees vary so widely, that it is not considered practicable to extend this provision to the work of different committees. The Secretary of the Association shall endeavor however, to secure uniformity between specifications prepared by different committees.

(*D*) SPECIFIED VALUES:

15. "Desired values" rather than "permissible limits" shall be given followed by a statement with respect to "permissible variations". The term "permissible variations" shall be used in general, rather than the term "tolerance", except in connection with subjects in which the latter term is in better accord with recognized trade usage.

16. In so far as practicable, specified values shall be expressed in tabular form.

(*E*) UNITS OF MEASUREMENT:

17. Units of measurement shall be expressed in both the English and Metric systems, if, in the judgment of the committee concerned, it is desirable to do so. Temperatures shall be expressed in Centigrade values, and also in Fahrenheit values, if, in the judgment of the committee concerned, it is desirable to do so.

(*F*) TYPOGRAPHY, TERMS, ABBREVIATIONS, SPELLING, ETC:

18. Committees should follow the practice in typography, terms, abbreviations, spelling, etc., as recommended in the "Suggestions to Authors" of the American Institute of Electrical Engineers, "Style Sheet" of the American Society of Mechanical Engineers, and "Regulations Governing Form of Specifications" of the American Society for Testing Materials, which have been collated and are here given for the guidance of Committees.

LIST OF ABBREVIATIONS

Name	*Abbreviations*
Afternoon	p. m.
Agent	Agt.
Alabama	Ala.
Alaska	spell out
Alternating Current	spell out, or a-c. when used as compound adjective.
American	Am.
American Electric Railway Association or allied associations	spell out except after name of member.
Amperes	spell out
Architect	Arch.
Arizona	Ariz.
Arkansas	Ark.
Assistant	Asst.

Name	*Abbreviations*
Associate	Assoc.
Attorney	Atty.
Auditor	Audr.
Avenue	Ave.
Barrels	bbl.
Birmingham wire gauge	B. w. g.
Board	Bd.
Boiler horse power	Boiler h. p.
Borough	Boro.
Brake horse power	b. h. p.
British Thermal units	B. t. u.
Brothers	Bros.
Brown & Sharpe (gauge)	B. & S.
Building	Bldg.
Bushels	Bu.
California	Cal.
Calories	cal.
Candle Power	c.p.
Captain	Capt.
Centigrade	cent.
Centigram	cg.
Centiliter	cl.
Centimeter	cm.
Chemically pure	c.p.
Chemist	Chem.
Chief	Ch.
Circular mils	cir. mils.
Civil Engineer	Civ. Engr.
College	Coll.
Colorado	Colo.
Commissioner	Comr.
Committee	Comm.
Company	Co.
Connecticut	Conn.
Consolidated	Consol.
Construction	Constr.
Constructing Engineer	Constr. Engr.
Consulting Engineer	Cons. Engr.
Contracting Engineer	Contr. Engr.
Cosine	cos.
Cotangent	cot.
Counter Electromotive force	counter e. m. f.
County	Co.
Cubic	cu.
Decaliter	dal.
Decigram	dg.

Name	*Abbreviations*
Decileter	dl.
Decimeter	dm.
Degrees	deg.
Delaware	Del.
Diameter	spell out
Department	Dept.
Director	Dir.
Direct Current	spell out or d-c when used as compound adjective.
District of Columbia	D. C.
Draftsman	spell out
East	E.
Electric	Elec.
Electric horse power	e.h.p.
Electrical Engineer	Elec. Engr.
Electromotive force	e.m.f.
Engine	Eng.
Engineer	Engr.
Engineering	Engrg.
Equipment	Equip.
Executive	Exec.
Fahrenheit	Fahr.
Feet	ft.
Florida	Fla.
Foot-pounds	ft. lb.
Forenoon	a. m.
Foundry	Fdy.
Gallons	gal.
General	Genl.
Georgia	Ga.
Grains	gr.
Gram	g.
Gram-Calories	g-cal.
Heating Engineer	Heat. Engr.
Hectare	ha.
Hectoliter	hl.
High-pressure cylinder	spell out
His Majesty's Ship	H.M.S.
Honorable	Hon.
Horse power	h.p.
Hours	hr.
Hydraulic Engineer	Hyd. Engr.
Idaho	spell out
Illinois	Ill.
Inches	in.
Incorporated	Inc.

Name	*Abbreviations*
Indiana	Ind.
Indicated horse power	i. h. p.
Inspection	Inspc.
Inspector	Inspr.
Institute	Inst.
Instructor	Instr.
Insurance	Ins.
International	Internatl.
Iowa	Ia.
Kansas	Kan.
Kentucky	Ky.
Kilogram	kg.
Kilogram-calories	kg-cal.
Kilogram-meters	kg-m.
Kilometer	km.
Kilovolt-amperes	kv-a.
Kilovolts	kv.
Kilowatt-hours	kw-hr.
Kilowatts	kw.
Lieutenant	Lieut.
Limited	Ltd.
Linear	lin.
Liter	l.
Locomotive	Loco.
Louisiana	La.
Machine	Mch.
Machinery	Mchy.
Magnetomotive force	m.m.f.
Maine	Me.
Maryland	Md.
Manager	Mgr.
Manufacturer	Mfr.
Manufacturing	Mfg.
Marine Engineer	Mar. Engr.
Master Car Builder	M. C. B.
Master Mechanic	M. M.
Massachusetts	Mass.
Mean effective pressure	spell out
Mechanical	Mech.
Mechanical Engineer	Mech. Engr.
Meter	m.
Meter-kilograms	m-kg.
Michigan	Mich.
Microfarad	spell out
Miles	spell out
Miles per hour per second	miles per hr. per sec.

Name	*Abbreviations*
Milliliter	ml.
Milligram	mg.
Millimeter	mm.
Mining Engineer	Min. Engr.
Mining	Min.
Minnesota	Minn.
Minutes	min.
Mississippi	Miss.
Missouri	Mo.
Montana	Mont.
Months	spell out
Motive Power	M. P.
National	Natl.
Nebraska	Neb.
Nevada	Nev.
New Hampshire	N. H.
New Jersey	N. J.
New Mexico	N. Mex.
New York	N. Y.
North	N.
North Carolina	N C.
North Dakota	N. Dak.
Number	No.
Ohio	spell out
Ohms	spell out
Oklahoma	Okla.
Oregon	Ore.
Ounces	oz.
Pennsylvania	Pa.
Per	spell out
Percentage	per cent or % in tabular matter
Place	Pl.
Pneumatic	Pneu.
Post Office	P. O.
Pounds	lb.
Power Factor	spell out
President	Pres.
Proceedings	Proc.
Professor	Prof.
Proprietor	Prop.
Refrigerating Engineer	Refrig. Engr.
Railroad	R. R.
Railway	Ry.
Representative	Rep.
Resident	Res.
Revolutions per minute	r. p. m.

Name	*Abbreviations*
Rhode Island	R. I.
Seconds	sec.
Secretary	Secy.
Sine	sin.
South	S.
South Carolina	S. C.
South Dakota	S. Dak.
Specific Gravity	sp. gr.
Square	sq.
Square-root-of-mean-square	Effective or r.m.s.
Stere	s.
Street	St.
Superintendent	Supt.
Superintending	Suptg.
Tangent	tan.
Technical	Tech.
Tennessee	Tenn.
Texas	Tex.
Ton-Mile	spell out
Tons	spell out
Treasurer	Treas.
T-Rail or Tee-Rail	T-Rail
United States (gauge)	U. S.
United States	U. S.
United States Army	U.S.A.
United States Navy	U.S.N.
University	Univ.
Utah	spell out
Ventilating Engineer	Vent. Engr.
Vermont	Vt.
Vice-President	V.P.
Virginia	Va.
Volt-amperes	spell out
Volts	spell out
Volume	vol.
Washington	Wash.
Watt-hours	watt-hr.
Watt	spell out
Watts per candle power	watts per c-p.
West	W.
West Virginia	W. Va.
Wisconsin	Wis.
Works	Wks.
Wyoming	Wyo.
Yards	yd.
Years	spell out

USE OF ABBREVIATIONS

Use "Fig.", not "Figure." Example: "Fig. 3", not "Figure 3."

In all decimal numbers having no units, a cipher should be placed before the decimal point. Example: "0.32 lb.", not ".32 lb."

Use the word "by" instead of "x" in giving dimensions. Example: "8 by 12 in.", not "8 x 12 in."

Never use the characters (′) or (″) to indicate either feet or inches, or minutes and seconds as period of time.

Do not use the expression "rotary" or "rotary converter"; use "converter" or "synchronous converter."

Do not use a descriptive adjective as a synonym for the noun described. Example: "a short circuit," not "a short."

Do not use the words "primary" and "secondary" in connection with transformer windings. Use instead "high-tension" and "low-tension."

Avoid symbols wherever possible.

Use abbreviations only after a noun denoting definite quantity. "The power plant has a capacity of 10 h. p.", not "10 horse power." But, "The capacity of the power plant, in horse power, is ten."

Do not abbreviate abstract or descriptive words. Example: "Horizontal return tubular boilers," not "h. r. t. boilers."

Use lower case characters for abbreviations. An exception to this rule will be made in the case of words spelled normally with a capital. Example: "B. t. u", not "b. t. u." or "B. T. U." (British thermal units).

Use a period after each abbreviation. In a compound abbrevation, do not use a space after the period. Example: "i.h.p.", not "i. h. p." (Indicated horse power).

Use a hyphen to connect abbreviations in cases where the word would take a hyphen if written out in full. When a hyphen is used, omit the period immediately preceding the hyphen. Example: "3 kw-hr." not "3 kw.-hr."

Use all abbreviations in the singular. Example: "17 lb.," not "17 lbs."

Spell out the name of the month in giving the date of birth.

Write January 25, not January 25th or the 25th of January.

Do not use st, d, rd, or th, with numerals.

Spell out the names of companies, railroads, etc., using the "short and" (&) only between proper names. Example: "Brown & Sharpe Mfg. Co.", but "The American Smelting and Refining Co."

Abbreviate Company in firm names. Example: "John Brown & Co."

In giving a title, use Dr., Prof., etc. where initials or full name is given. Spell out where only surname is given. Example: "Dr. James P. Gordon," but "Doctor Gordon."

Abbreviate States and Territories according to list.

Do not abbreviate company names further than authorized by standardized list of abbreviations.

Never use "p" for "per", but spell out the word. Example: "60 miles per hr."

Use decimals as far as possible, instead of vulgar fractions. Example: "1.25 ft." not "1-1/4 ft."

In general, spell out an adjective qualifying the name of a unit. Example: "Boiler h. p." Exceptions — i. h. p.; e.h.p.; b.h.p.; e.m.f.; m.m.f.

In the notation of large numbers, use "en" spaces instead of commas. Example: "1 520 125", not "1,520,125."

NOTATION

The following notation, forming Paragraph 324 of Section V of the Standardization Rules of the A. I. E. E., is here reprinted.

Name of Quantity	Symbol	Unit
Voltage, e. m. f., potential difference	*E*, *e*	volt
Current	*I*, *i*	ampere
Resistance	*R*, *r*	ohm
Reactance	*X*, *x*	"
Impedance	*Z*, *z*	"
Admittance	*Y*, *y*	mho
Conductance	*G*, *g*	mho
Susceptance	*B*, *b*	"
Power	*P*, *p*	watt
Capacity	*C*, *c*	farad
Inductance	*L*,	henry
Magnetic density	β	gauss
Magnetic flux	ϕ	maxwell
Magnetic force	*H*	gilbert per cm.
Length	*L*, *l*	cm. or inch.
Mass	*M*, *m*	gm. or lb.
Time	*T*, *t*	second or hour

Note: Letters to be printed in italics should be underlined.

E_m, I_m and B_m should preferably be used for maximum cyclic values, *e*, *i* and *p* for instantaneous values, *E*, and *I* for r.m.s. values and *P* for the average value or effective power. These distinctions are not necessary in dealing with continuous-current circuits. Vector quantities are preferably represented by bold-face capitals.

RULES FOR USE OF NUMERALS

Do not begin a sentence with figures.

Spell out all numbers from one to twelve.

Exceptions: Do not spell out mixed numbers.

Example: 1-1/2. When a number below twelve is followed by an authorized abbreviation, use the figures.

Example: "2 in."

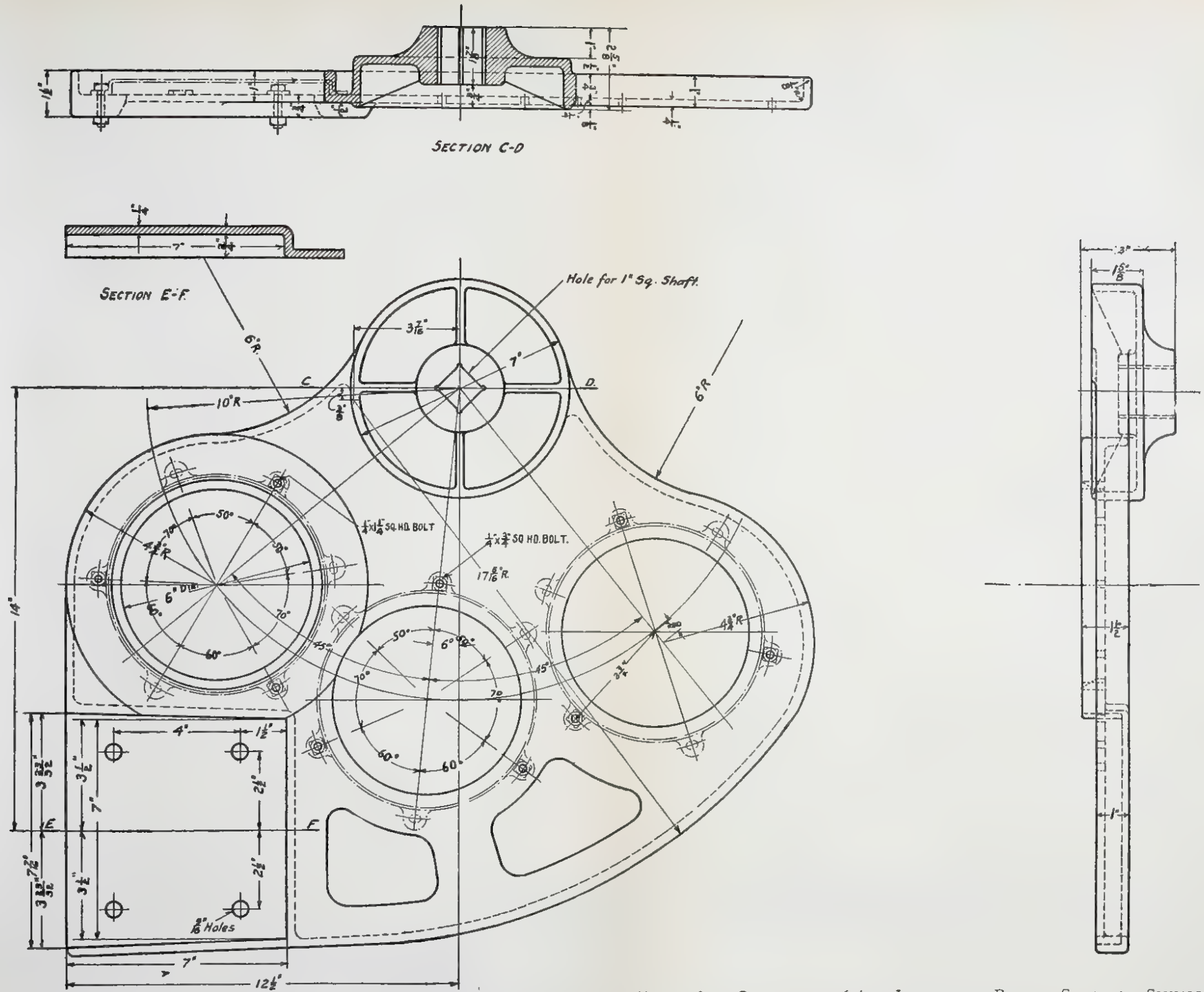


FIG. 1. DESIGN OF SPECTACLE FOR LEFT-HAND UPPER QUADRANT 90 DEG. SEMAPHORE HAVING 6 IN. OPENINGS AND 6½ IN. LENSES FOR 3-POSITION SEMAPHORE SIGNALS AND FOR USE WITH 3 FT. 6 IN. POINTED BLADE, RECOMMENDED FOR ADOPTION AS A RECOMMENDED DESIGN.

If a vague statement is made, as when the word "about" is used, write out the number.

In a series of connected numerical statements where precision is implied, use numerals only: as "2 foremen, 7 masons, 7 laborers."

Use numerals in such expressions as 7-story building, 3-mile railway, etc. When one number immediately follows another, spell out the smaller.

Use the word "by" instead of "x" when given dimensions.

In specifications where dimensions or allowable variations are given, words and figures should always be used. Example: "The length of frog and crossing arms shall be sufficient to give at least six and one-quarter (6.25) inches clearance between vertical webs at end of joint plates with a minimum length of three (3) feet unless adjoining piece will not permit.

RECOMMENDATION FROM PREVIOUS REPORTS

Spectacle for Left Hand Upper Quadrant 90 Deg. Semaphore Signals

This design was recommended for adoption as a Standard by the 1914 Committee on Block Signals (see 1914 Proc., page 173 and 180) and approved for adoption by the 1914 Conventions (see 1914 Proc., page 238). Your Committee has voted to approve this as a Recommended Design in view of the fact that the other detailed designs for semaphore block signals were approved by the Committee on Standards as Recommended Designs instead of as Standard Designs, as recommended by the previous Committee on Block Signals.

ACTION ON CURRENT RECOMMENDATIONS

Proposal	Recommendation of: Standing committee	Recommendation of: Committee on standards
By Committee on Power Distribution:		
Specification for Concrete Poles..	Continuance and presented modified specification.	That the Specification be incorporated in Section Ds 3a of Engineering Manual.
Specification for Tubular Steel Poles.	Amended Sec. 8, 9, 11 and 14 of Specification shown in Engineering Manual Ds 5a.	That changes as recommended be adopted.
Table for Deflection and Loads and Pipe Table for Tubular Steel Poles.	That they be substituted for tables shown in Sec. Ds 3a of Engineering Manual and be incorporated in Standard Specification for Tubular Steel Poles.	Approved.
Specification for Overhead Line Material.	Recommended Specification....	Adopted as Recommended Specification.
Revision of Sec. 81 and 82 on Lightning Arrester Location and Grounds.	Amended and submits for adoption in lieu of present.	Approved.
Specification for 600 Volt D. C. Overhead Trolley Construction.	Recommends for adoption amendments to various sections.	Recommends revised sections be adopted.
Specifications for Joint Use of Poles.	That the specification be printed in Engineering Manual under Miscellaneous Methods and Practices with wording of American Association resolution.	Approved.

Proposal	Recommendation of: Standing committee	Committee on standards
A. I. E. E. Rules 321–366; 379–381; 388; 389; 404–414.	Suggested that definite division between transmission and distribution system be outlined.	That they be given further study as they have been revised since being considered by Committee.
Clearance Diagram for Semaphore Signals.	See Report of Committee on Block Signals.	
By Committee on Heavy Electric Traction:		
Clearance Line for Third-Rail Working Conductors.	Recommended modification of the present Standard.	Approved changes.
Definition — Third-Rail Gauge..	Recommended definition as follows: "Distance measured parallel to plane of top of both running rails between gauge of nearest running rail and inside gauge line of third-rail."	Adoption as Standard approved.
Protection of Contact Rail where protected Third-Rail is used for Rapid Transit Operation.	Recommended where top contact rail is used, that Type A construction be established as Recommended Design; if under-running type of third-rail is used, that Type B construction be established as Recommended Design.	Adoption as Recommended Design, approved.
By Committee on Block Signals:		
Design of Signal Apparatus....	Adoption as Standard — Fig. 2 to 12 inclusive.	Adopted as a Recommended Design.
Clearance Diagram for Semaphore Signals.	Adoption as a Standard.....	Referred back to Committee to consider with Committee on Heavy Electric Traction.
Changes in Sec. Ss 5a of Engineering Manual — Light Aspects in 3-Position Signaling, employing signals operated by contactors.	That words "Non-Car Counting" and "Car Counting" be changed to read "Non-Registering" and "Car-Registering."	Approved.
By Committee on Power Generation:		
Specification for Lapwelded and Seamless Boiler Tubes.	For adoption as Standard.....	Approved as Standard.
Consideration of Boiler Code of A. S. M. E.	That it be given further consideration.	Referred back to Committee for further consideration.
Specification for Purchase of Fuel.	That it be embodied in Engineering Manual. Further study may be advisable.	Publication in Engineering Manual under Miscellaneous Methods and Practices approved.
Specification for Power Station Lubricants.	That it be given further study..	Approved.
Analysis of Cost of Power Station Operation.	That the Subdivision of Accounts covering Costs be submitted to Committee on Engineering-Accounting for suggestion and approval. That the subject be continued by ensuing Committee.	Approved.
A. I. E. E. Rules.— 1–320; 367–387; 390–392.	That these rules be recommended to the consideration of the members of the Association.	That they be givea further study they have been revised since being considered by the Committee.
By Committee on Buildings and Structures:		
General Specification and Form of Contract for Railway Structures.	That it be adopted as a Recommendation.	Disapproved inasmuch as this Specification and Form of Contract are not suitable for adoption as a Standard or Recommendation.

Proposal	Recommendation of: Standing committee	Recommendation of: Committee on standards
Rules for Instruction to Employes for Fire Protection.	Adoption as recommended Rules	Adoption as Recommended Rules approved.
By Committee on Way Matters:		
Types of Track Construction Type B — Type C.	Adoption as Recommended Designs.	Approved. Type B. On Type C action withheld until after Convention.
Classification of Soils.....	Adoption as a Recommended Practice.	Disapproved but to be inserted in Engineering Manual under Miscellaneous Methods and Practices.
Design—Joint for 7-in. 80 lb. and 7-in. 91 lb. plain girder rails.	Adoption as a Recommended Design.	Approved as a Recommended Design.
Drilling for Standard Section Rails (A. E. R. A. Standard).	Adoption as a Recommended Design, for use with 80, 90 and 100 lb. standard rails.	Approved as Recommended Design.
Recommended Symbols for Recording Surveys — Sec. Wm 2a.	To change title to "Conventional Signs for Recording Surveys" and adopt as Recommended Practice the signs adopted by the I. C. C. with modifications, superseding present Recommendation.	Disapproved and referred to Executive Committee for consideration jointly with committees, in order that all symbols may be included in the revision.
Section Wm 4a, Specification for Splice Bars and Joint Plates.	Recommended dimension of 1 inch be inserted as indicating thickness of plate on head side of rail at center of bolt hole.	Approved.
Section Wr 1a T-Rails for Use in Paved Streets.	Change title to read: "Plain Girder Rails in Paved Streets," and that it be divided into two sections: 1. Designs for Plain Girder Rails. 2. Plain Girder Rails for Use in Paved Streets. That the subject matter now given in Engineering Manual on T-rails for use in paved streets be revised. Revision submitted. That designs of Standard Section Rails be made into 3 separate parts — 80, 90 and 100 lb. sections. These drawings to follow subject matter of new section. Present Recommended Design for 7 in. 80 lb. plain girder rail be retained. That 7 in. 100 lb. plain girder rail section be withdrawn, there being no demand, and a 7-in. 91 lb. plain girder (P. S. Co. 282 or L. S. Co. 91–375) be substituted.	Approved.
Specifications for Special Work..	Adoption as a Recommended Specification. Work to be continued by ensuing Committee.	Approved.
By Committee on Equipment:		
Revised Standard Specification for Heat Treated Carbon Steel Axles, Shafts and Similar Parts, changing title to Specification for Quenched and Tempered Carbon Steel Axles, Shafts and Similar Forgings.	Standard Specification to supersede present Standard.	Standard Specification.

Proposal	Recommendation of: Standing committee	Recommendation of: Committee on standards
Revised Standard Specification for Annealed Carbon Steel Axles, Shafts and Similar Parts, changing title to Specification for Annealed Carbon Steel Axles, Shafts and Similar Forgings.	Standard Specification to supersede present Standard.	Standard Specification.
Specification for Case Hardened Forged Steel Gears.	Recommended Specification....	Recommended Specification.
Specification for Quenched and Tempered Forged Carbon Steel Gears.	Recommended Specification....	Recommended Specification.
Specification for Case Hardened Forged Steel Pinions.	Recommended Specification....	Recommended Specification.
Specification for Quenched and Tempered Forged Carbon Steel Pinions.	Recommended Specification....	Recommended Specification.
Revised Specification for Air Brake Hose.	Recommended Specification to supersede present Recommended Specification adopted in 1914. (See 1914 Proceedings, p. 292.)	Recommended Specification.
Revision of Steel Wheel Design:		
Dimensions of Rolled Steel Wheels of 2½-in. tread and 21-in. to 37 in. diameter.	Recommended Design.....	Referred back to Committee for consideration in conjunction with the Design of Contour of Tread and Flange and further study as to Thickness of Rims.
Standard Rolled Steel Wheel Design for 3 in. and 3½ in. tread.	Recommended Design	
Revision of Tread and Flange Contour.	Investigated next year, due to adoption of different design by C. E. R. A.	Referred back for further study.
Proof Testing of Forgings.....	That Report of Sub-committee be printed in Engineering Manual under Miscellaneous Methods and Practices, as a general guide in proof testing axles and similar forgings.	Action approved.
Rules for Car Wiring.....	That they be printed in Engineering Manual, under Miscellaneous Methods and Practices.	Action approved.
Height of Platforms for City and Interurban Cars, part of Section Ec 1a of Engineering Manual.	In so far as this concerns city cars, it should be eliminated.	Action approved.
Standardization Rules of A. I. E. E. 247–320; 370–381; 415–430; 436–449 inclusive.	Referred to Association for approval.	That they be given further study as they have been revised since being considered by Committee.

Respectfully submitted,

C. F. Bedwell,
W. G. Gove,
E. R. Hill,
A. S. Richey,
J. W. Welsh,
C. S. Kimball,
E. B. Katté,
W. H. Sawyer,
F. R. Phillips,
J. H. Hanna,
C. H. Clark,
Martin Schreiber, *Vice-Chairman,*
H. H. Adams, *Chairman.*
Committee on Standards.

PRESIDENT CRECELIUS:— As Mr. Gove has pointed out we will consider at this time merely the report of the Committee on Standards as a whole, reserving our approval of the action of the Committee on Standards upon specific recommendations of the various committee reports as these reports are being considered. The report is now in order for discussion.

Discussion of Report of Committee on Standards

C. R. HARTE:— There is one point I would like to bring up in connection with this standard form for specifications. I do not know whether the Committee on Standards has this in mind or not, but I should be very sorry to see the Association accept and make standard a form which would require a separate and elaborate specification, largely formal and unnecessary, for each article considered. I think that we have gone altogether too far in that direction in the past.

The elements of agreement, such as who are the parties, what they propose to do, and how they propose to do it, are all part of the contract; the specification proper is the description of the product of the acts of the contract, and it should be confined to this, but as a matter of fact a great many "specifications" consist of several pages which describe in great detail who is the purchaser and who is the seller, enlarge on the fact that the specification must be followed in all respects, and then devote a few lines to a description which not unfrequently is the statement that it is "as per attached drawing." I know of several companies which have specifications of which over 90 per cent of the text is contractual or otherwise unnecessary, and is repeated for each article.

The purpose of the specification is to describe in detail what is to be produced under the contract, and its chief use is not by lawyers but by business men. It should therefore be as brief as is consistent with making it not merely so that it can be understood, but so that it cannot be misunderstood.

My own idea of the desirable form is that which has been followed by the Committee on Power Distribution in reporting on Overhead Materials, where all materials of a given class are grouped together with first a statement of general facts applying to all material of that class, and next brief specific descriptions of each of the kinds of that material.

There are many articles which are alone in their class, and must therefore have individual specification, but there are many others which can and should be grouped in specifying precisely as they are grouped in buying because of common characteristics of manufacture, purchase, or use, and I sincerely trust that it is in this spirit that the Committee is working up the standard form.

PRESIDENT CRECELIUS:— Just before asking Mr. Gove to close the discussion, the Chair desires to call attention to the fact that it was impossible to issue the 1914 revisions required for the *Engineering Manual* — but we have been advised by our secretary that immediately after this Convention the *Manual* will be revised so as to include all the Standards and Recommendations adopted up to and including the 1915 Convention. Mr. Gove, will you please close the discussion?

W. G. GOVÉ:— The points raised by my friend, Mr. Harte, are all very pertinent. I agree with him in a general way in what he says — that is, unless we make our specifications brief and to the point they are of little value. We all know that oftentimes, and especially when an attempt is made to incorporate a contract with the specification, that it leads to long terms and paragraphs that mean very little except to the legal department, or perhaps to those who may wish to break the contract through the process of its execution. I am sure that every point of that kind has been thoroughly considered by the Committee on Standards. In fact, I know that it has. One of the most active workers on that subject, and from whom quite a little of this data has been obtained, is Mr. Martin Schreiber, one of the past-presidents of this Association.

A great deal of material is purchased on our own system under contracts and a great deal is purchased by purchasing agents' order, which has a brief form of contract on the back. These forms of contract I understand are in very general use both by the large companies and the smaller companies throughout the country.

The main point in this matter at the present time is this — there is no question but that any form of specification such as put forth by the Committee on Standards would have to

be revised. The main point is to get something started. The Engineering Association, it seems to me, has a big field in the purchasing of material for the various companies which it represents. In the future, no doubt, much more will be done towards the checking up of material, at least, than has been done in the past. Up to the present time it has been largely a question of purchasing one material or another and accepting whatever has been delivered by the manufacturing companies. From now on, when we are all striving to obtain, perhaps, better materials for various reasons, and also to obtain the best materials for certain prices, it will be found, undoubtedly, to be desirable, and I believe in most cases necessary, to make check analyses, checking up more carefully the materials received, oftentimes running into many thousands of dollars on single purchases. Various companies have different methods. Some buy large amounts on contract. We have on our own system now $150,000 worth of wheels, and axles and gears for 1916 requirements. We buy these once a year. The purchasing agent arranges the transaction, takes the bids, and sets up the contracts with the legal department, the final action being taken by the contract committee of the executive committee of the board of directors. Much of the material, however, is bought by the purchasing department direct.

The main point, however, is in some way to get a style of specification which will be more or less in line with our standardization work. That is, to follow in a measure, the action that has been found desirable and that has been taken by the well known societies to which I have already referred. I am a member of the American Society of Civil Engineers, which was established in 1847. It is an old society. The American Society of Mechanical Engineers, the American Institute of Electrical Engineers are similar institutions. They have certain forms, certain terms, in their specifications, and the American Electric Railway Engineering Association should work along the same lines. In a measure it should follow the work that the American Railway Master Mechanics Association has done and the Master Car Builders Association of the steam railways. Of course, they have been established

longer than we have been and have had more experience in certain ways.

Now, what we want to do is to get something started. We had no intention of asking this Convention to accept as a Standard, the Form for Specifications mentioned in this report, but we do propose this as a tentative form to be used by the various companies in their work, and criticisms and suggestions will be welcomed from them with a view towards obtaining improvements in our proposed form when it again comes up for consideration within a year or possibly within two years. We hope, though, within a few years, to make a definite recommendation as to some standard form of specification, and that may be very brief. I agree with Mr. Harte it should be as brief as possible, and still cover the field in a satisfactory way to the large companies and the small companies, the companies east and the companies west, anywhere throughout the United States, and to embody such work as we may be called upon to take up, whether it be placed under contract form or purchased through the various purchasing departments.

PRESIDENT CRECELIUS:— This report bears evidence of very hard work. As a matter of interest, I might state that in addition to the preparation of the report as a whole the Committee on Standards has put in a very busy session upon a review of the recommendations of our various standing committees.

C. R. HARTE:— In moving a vote of thanks to the Committee on Standards for this admirable report I desire to make it clear that my discussion was not intended as a criticism of the report. I think that this specification form lends itself admirably to exactly what I had in mind, and in speaking as I did I simply wanted to point out to you that in my judgment we do not want to fill out this skeleton in full detail for each separate item but we should rather group and treat together as many items as by their character will so permit. Mr. Chairman, I move a vote of thanks to the Committee for their admirable work, and the acceptance of the report.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— We now come to the report of one of our principal standing committees, namely, the Committee

on Power Distribution. This report carries with it eight distinct recommendations which have received the action of the Committee on Standards. I regret that Professor A. S. Richey, the chairman of the committee, is not able to be present, and the report will be presented by Mr. E. J. Blair, a member of the committee.

E. J. BLAIR:— The Committee on Power Distribution tried to do a good deal of preliminary work this year by correspondence, together with some sub-committee meetings, and finally met for one joint meeting occupying two days at which the work was summed up and put in final shape.

As to the concrete poles, the committee has in mind further work in this matter, and the securing of the coöperation of some university or large corporation. It is rather an expensive and slow proposition, and it would be a very fine subject for the students in some of the engineering universities to work on for a considerable length of time, their work being somewhat under the supervision of the Association. We have that thing in view and have put out one or two feelers to one of the universities in particular. I do not know what the result will be. So far as the concrete pole is concerned, this is simply a progress report, based on the square pole.

In connection with the matter of lightning arrester locations and grounds about which Mr. Phenicie spoke,* it was the Committee's idea, just as it was your President's, that further consideration of the subject of car lightning arresters would come under the heading of the work of the Committee on Equipment. The members of the Committee on Lightning Protection trust you will not simply pass that report by, but that the report may be amplified as the years go by through the further work of the committee to which this matter properly belongs. Criticisms or additions or amplifications of the work of the line lightning arrester problem coming up in the next two or three years will naturally be referred to the Committee on Power Distribution.

*See page 38.

REPORT OF THE COMMITTEE ON POWER DISTRIBUTION

To The American Electric Railway Engineering Association:

GENTLEMEN:— Your Committee on Power Distribution submits the following report:

About December 1st, 1914, the Executive Committee assigned the following subjects to this Committee for consideration:

1. Specifications for Reinforced Concrete Poles.
2. Revision of Standard Specifications for Tubular Steel Poles.
3. Specifications for Sundry Line Materials.
4. Revision of Sections 81 and 82 of Recommended Specification for 600 Volt Direct Current Overhead Trolley Construction (Lightning Arrester Location and Grounds).
5. Review of Existing Standards and Recommendations originating with Committee on Power Distribution.
6. Consideration of Standardization Rules of the American Institute of Electrical Engineers, Nos. 321–366, 379–381, 388 and 389, 404–414, all inclusive.

Under Subject 5, the Committee has considered revision of the following existing standards and recommendations:

(*a*) Recommended Specification for 600 Volt Direct Current Overhead Trolley Construction.

(*b*) Recommended Specification for Overhead Crossings of Electric Light and Power Lines.

(*c*) Standard Stranding Table.

(*d*) Standard Specifications for Rubber Insulated Wire and Cable.

The Committee has also considered under instructions from the Executive Committee, and in conjunction with the Committee on Block Signals, the Clearance Diagram for Semaphore Signals.

The subjects numbered above 1 to 6, inclusive, were on December 10th, 1914, assigned by the Chairman to sub-committees as follows:

On Concrete and Steel Poles (Subjects 1 and 2), Messrs. Rice, *Chairman,* Thompson and Cadle.

On Line Materials and Location and Grounds for Lightning Arresters (Subjects 3 and 4), Messrs Harte, *Chairman,* Palmer, Cadle and Woods.

On Review of Existing Standards and Standardization Rules of the American Institute of Electrical Engineers (Subjects 4 and 5), Messrs. Blair, *Chairman,* Crouse and Palmer.

Immediately thereafter, the Chairman was notified of a Special Committee on Lightning Protection consisting of representatives of the Committees on Power Distribution, Electrolysis, Equipment and Block Signals. Mr. Crouse was appointed on that committee to represent

the Committee on Power Distribution and he was later made Chairman of the Special Committee.

About January 1st, 1915 the Committee on Block Signals requested coöperation with the Committee on Power Distribution on the matter of a Clearance Diagram for Semaphore Signals, and this matter was handled through correspondence by the Chairman except as noted below.

The various sub-committees have held meetings as follows: Sub-committee on Overhead Line Material at New York, January 28th, 1915, February 25th and 26th, April 1st, 2nd and 3rd, May 13th and 14th, 1915. Sub-committee on Poles at Rochester, March 26th and 27th, and at New York, April 28th, 1915. Sub-committee on Revision of Existing Standards at New York, April 28th, 1915.

The Committee on Power Distribution held but one general meeting at New York on April 29th and 30th, 1915. A great deal of the work both of the sub-committees and of the general committee has been handled by correspondence between the members and conferences of two or more members at various times and places.

CONCRETE POLES

In the 1913 report of the Committee on Power Distribution (and Engineering Manual Ds 3a) there was developed a formula for the deflection of poles, and that formula was further amplified to cover the case of a concrete pole of a special design. A table of deflections was also presented covering this special pole, and dimensions and weights were given, on the basis of securing a concrete pole which would perform the same service as the standard steel pole. This special design was a square pole of practically constant cross-section. It was not intended as a final design but was only a step in the investigation, and it was expected that the Committee would be able later to build poles for test and then modify its design in the light of the experience secured. In the 1914 report the design was extended to include hexagonal and octagonal sections and formulæ were presented showing deflections of these designs. In all of these cases, however, the poles were of practically constant cross-section with uniform reinforcement from top to bottom.

During the past year the New York State Railways Company, Rochester Division, built some poles to the Committee design and these were tested. The method of test was by attaching a cable to the pole and pulling by a car through block and tackle. A dynamometer inserted in the cable indicated the pull, and was read from the ground by means of a field glass. Fig. 1. shows a test as conducted at Syracuse, New York. The results of the tests showed that in general the theory was correct but that the constants involved in the final formulæ for deflections shown in the 1913 and 1914 reports would need to be modified. Results of these tests are given in Appendix **A**.

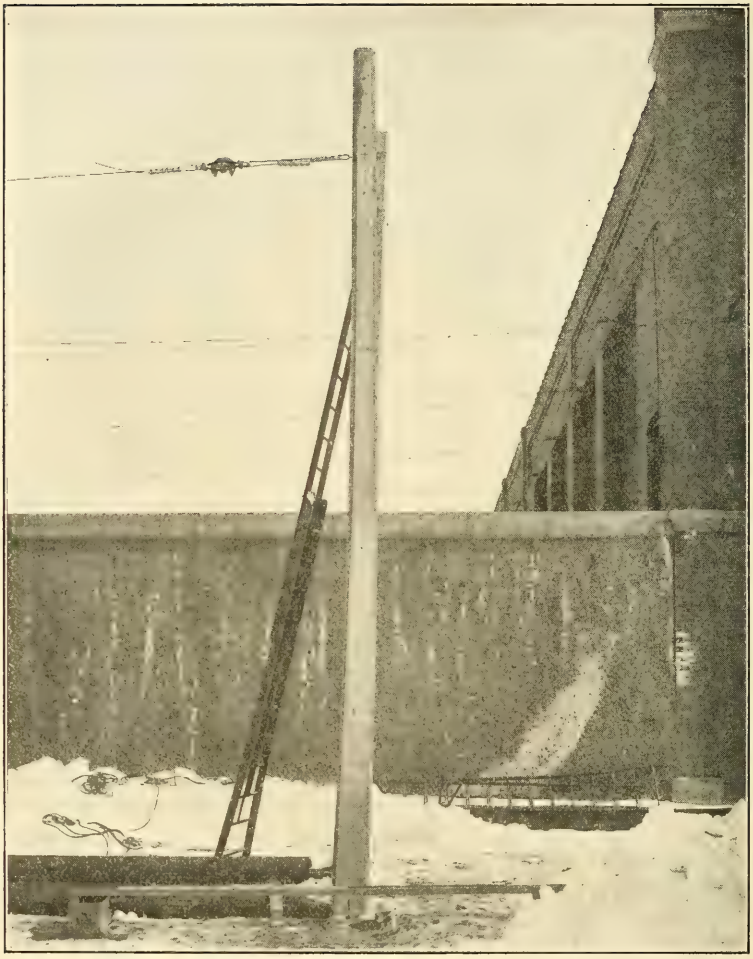


FIG. 1. TEST OF CONCRETE POLE AT SYRACUSE, N. Y.

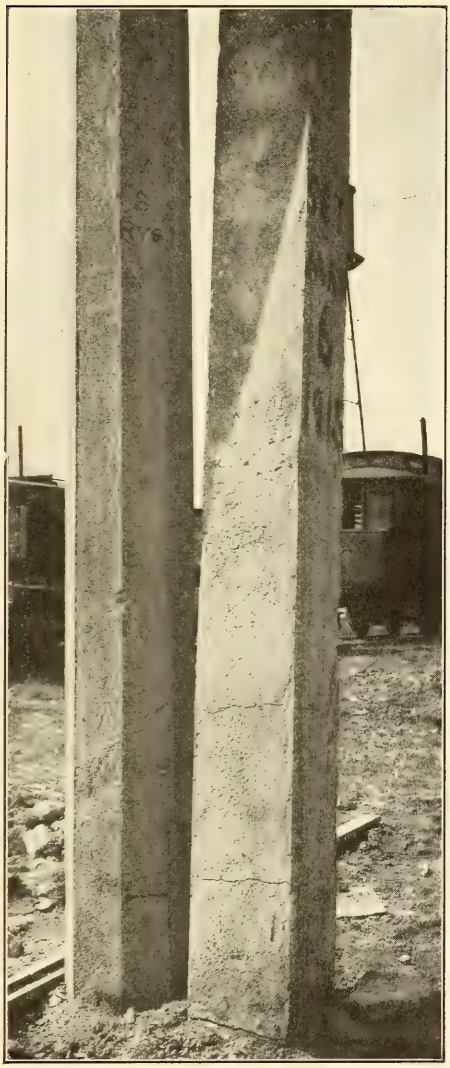


FIG. 2. SHOWING NEW YORK STATE RAILWAYS POLE BEFORE TEST, ALSO SHOWING TENSION CRACKS IN POLE UNDER TEST.

FIG. 3. SHOWING FAILURE OF NEW YORK STATE RAILWAYS POLE UNDER TEST.

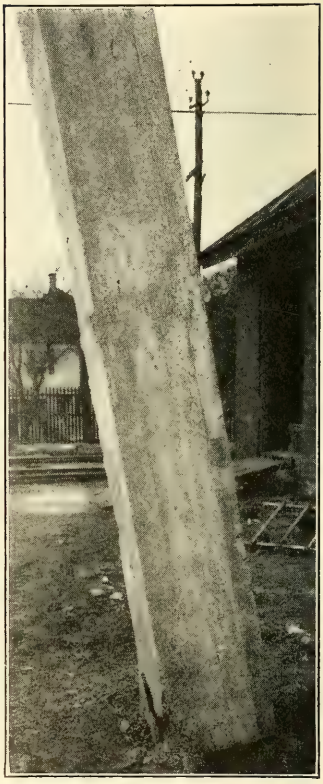


FIG. 4. SHOWING FAILURE OF CONCRETE POLE UNDER TEST.

A pole of the New York State Railways Company was also tested in comparison with the Committee pole and data on this test are included. Fig. 2 shows the railway company pole before test.

A great deal of concrete pole work has been done by the railway companies in Rochester, Syracuse and Cleveland. The accompanying sketch (Fig. 5) shows the general type of pole used in these three cities, with the character of reinforcement and the shapes of the sections. At Rochester about 1600 poles are in use, at Syracuse approximately 2500, and 2200 at Cleveland. To indicate more clearly the method of manufacture, the cost and details of the forms used, there has been prepared a description by one of the members of the Committee, which appears in Appendix **B**. Fig. 6 and 7 show details of the pole and the form as described.

The general results of all tests and experience of the Committee with concrete poles indicate certain facts which may be recorded:

1. Failure of a pole is always due to stretching of the reinforcing rods on the tension side.
2. A failure is always preceded by the appearance of hair-line cracks in the concrete on the tension side, at rather frequent and regular intervals from the ground line up.
3. It is advantageous to use a high grade of reinforcing steel to secure the maximum tensile strength.
4. Plain round reinforcing rods are essentially as satisfactory as twisted or other rough rods because in general the rods will elongate before they slip in the concrete.
5. A larger number of small rods is preferable to a smaller number of large rods as a better distributed reinforcement may be secured for a given amount of steel and a greater bonding contact surface is presented to the concrete.
6. The reinforcement need not be uniform throughout the length of the pole, but may be stepped off as the top of the pole is approached.
7. A pole with uniform reinforcement will break at the ground line, while one with tapered reinforcement will break at some point above the ground, depending upon the taper of the reinforcement.
8. A concrete pole has an element of safety in it as a failure of the pole will not in general allow it to fall to the ground. It is difficult at times to pull over a pole after failure, even though it is inclined at a large angle from the vertical.

Your Committee can report progress only and presents its statement with the following recommendations:

1. That the investigation of the subject of concrete poles be continued. It is hoped to secure some further experimental assistance in the design of poles.

2. That the material presented in this report be accepted as a statement of the best practice known to the Committee at this time.

3. That the formulæ and tables of deflections for a square uniform section pole presented in previous reports be considered as tentative only and not as the final values. The Committee hopes to be able to present later more flexible formulæ for computing deflections which will admit a design of non-uniform cross section. In view of this it has not been considered necessary to modify the formulæ and tables previously presented.

4. The Committee feels that some modification should be made in the specification presented in the 1913 report, and therefore submits the following modified specification. It believes that whatever the design may be this specification should be used in preference to that in the 1913 report.

SPECIFICATION FOR REINFORCED CONCRETE POLES

I. General

SCOPE:

1. This specification is intended to provide for all labor, tools and materials required for the manufacturing, furnishing, delivering and testing, in a complete and satisfactory manner, of reinforced concrete poles, for electric railway line construction.

DEFINITION OF TERMS:

2. The word *Company,* where occurring in this specification, shall mean the purchaser of the material referred to, or its authorized representative.

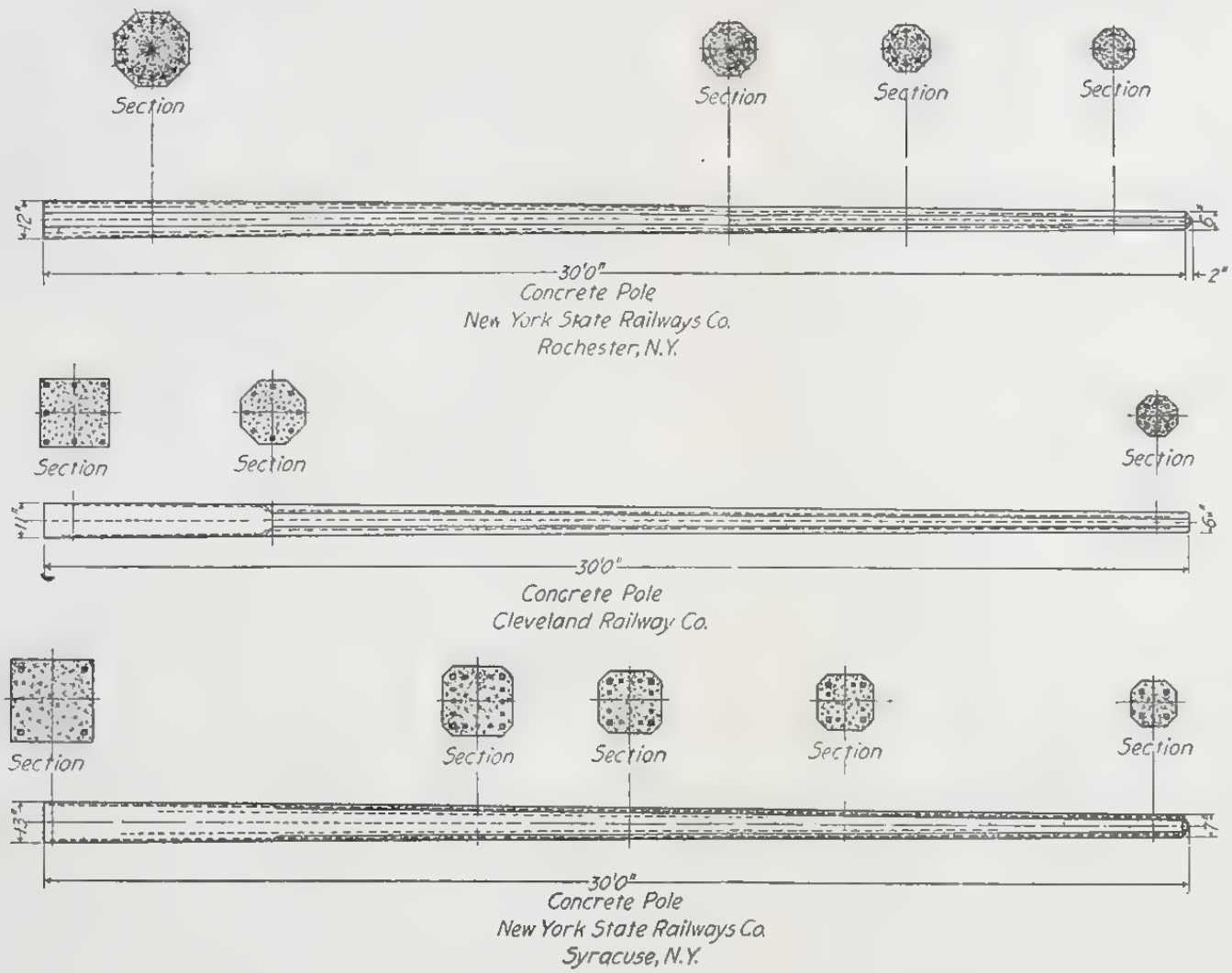
The word *Contractor,* where occurring in this specification, shall mean the party accepting the order to furnish the material referred to, or its authorized representative.

GUARANTEE:

3. The Contractor shall guarantee all his work and material to be strictly in accordance with the drawings and specifications and shall agree to amend and make good at his own expense immediately upon demand, any imperfections in the work due to the use of inferior material or to poor workmanship, which may appear within one year from date of final acceptance of the work.

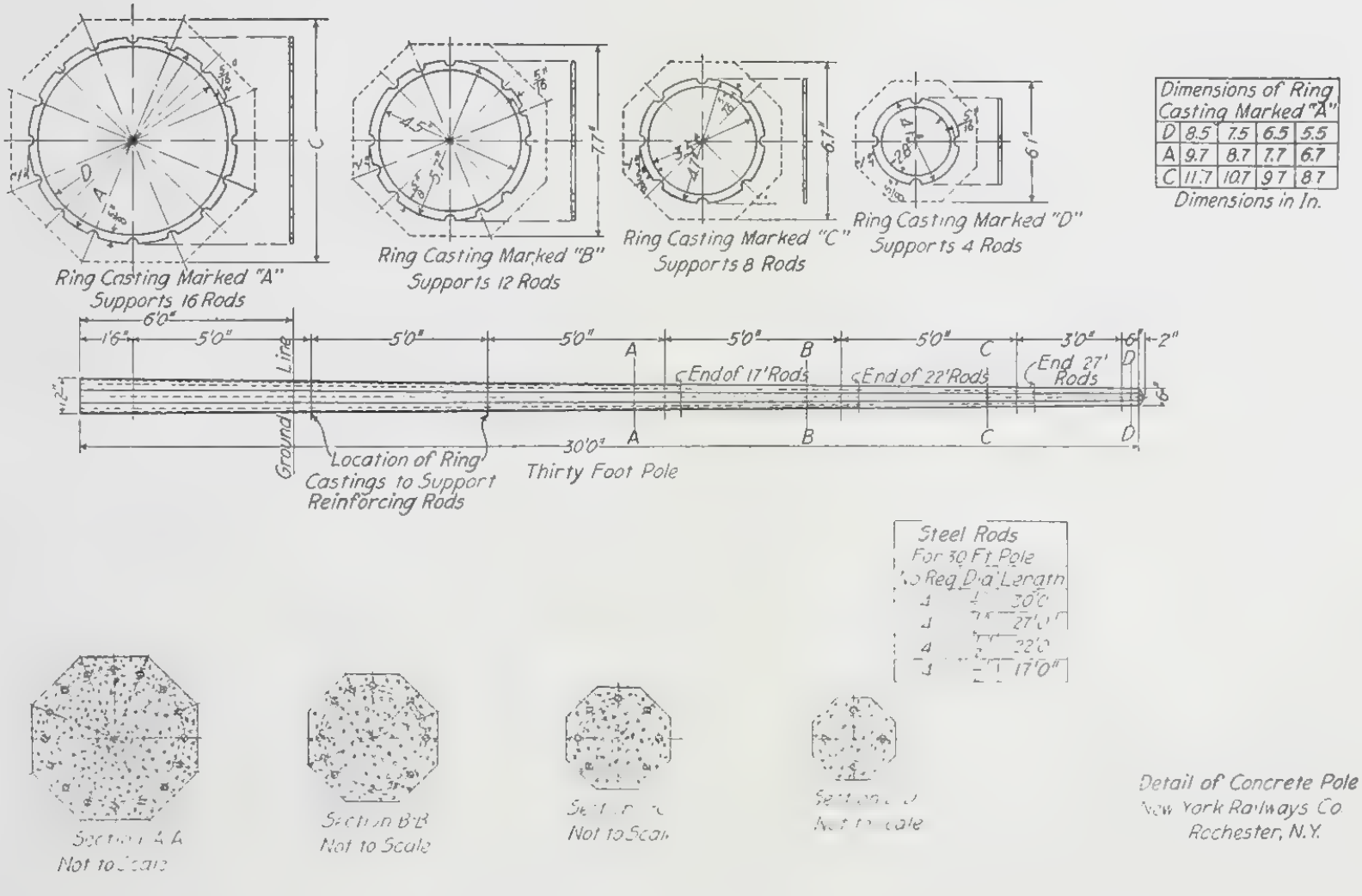
INSPECTION:

4. Material and workmanship of whatever kind or character shall be subject to the inspection and approval of the Company, either in place or at the point of delivery or manufacture, as may be stated in the contract. The Company shall be afforded all necessary facilities at all times to enable it to determine whether or not the materials and workmanship comply with this specification.



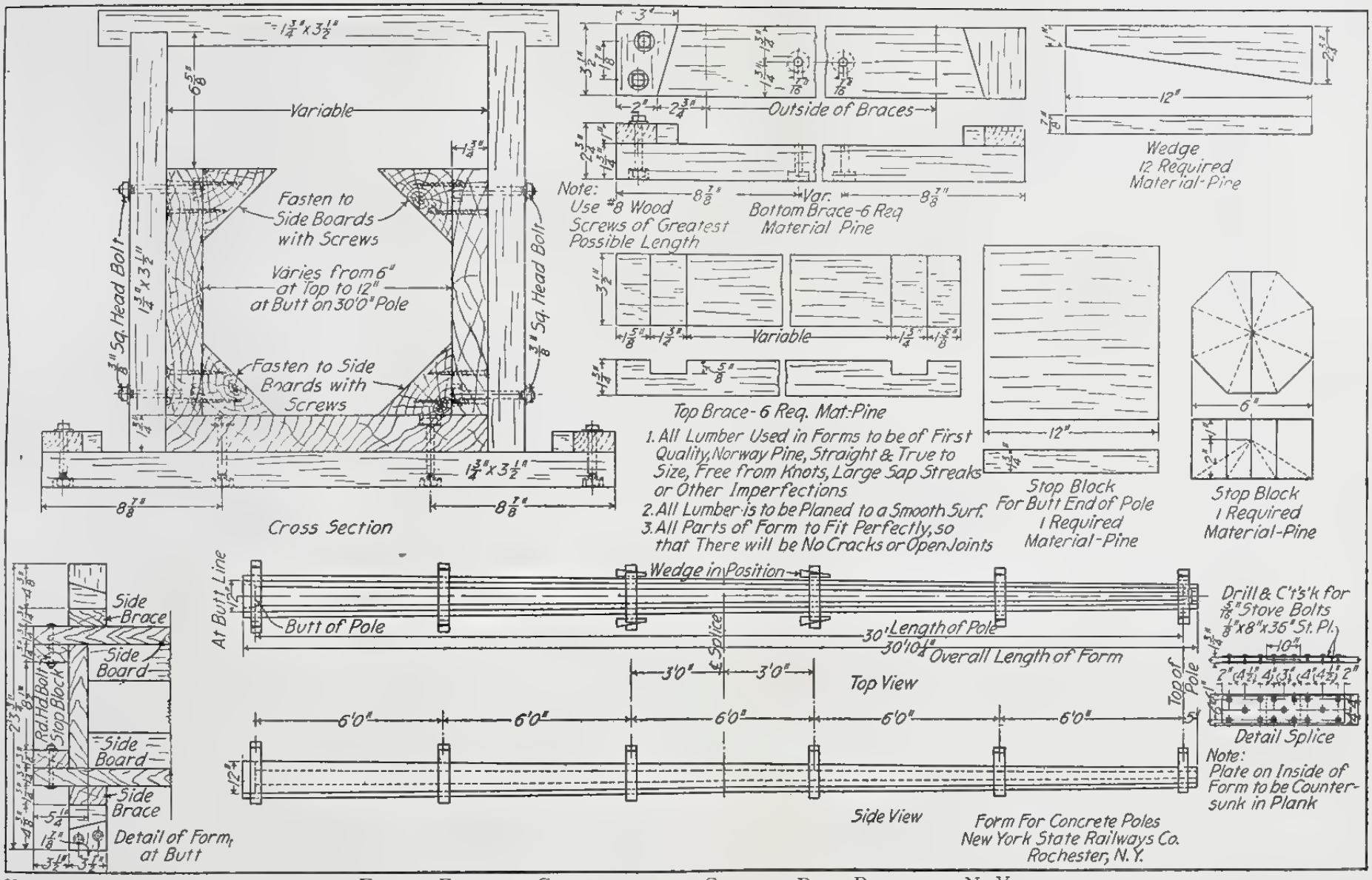
68a

FIG. 5. TYPES OF CONCRETE POLES AS USED AT ROCHESTER, CLEVELAND AND SYRACUSE.



68b

FIG. 6. DETAIL OF CONCRETE POLE, ROCHESTER, N. Y.


Variable
Fasten to Side Boards with Screws
Varies from 6" at Top to 12" at Butt on 30'0" Pole
Fasten to Side Boards with Screws
Cross Section
Outside of Braces
Note: Use #8 Wood Screws of Greatest Possible Length
Bottom Brace-6 Req Material Pine
Wedge 12 Required Material-Pine
Variable
Top Brace-6 Req. Mat:Pine
1. All Lumber Used in Forms to be of First Quality, Norway Pine, Straight & True to Size, Free from Knots, Large Sap Streaks or Other Imperfections
2. All Lumber is to be Planed to a Smooth Surf.
3. All Parts of Form to Fit Perfectly, so that There will be No Cracks or Open Joints
Stop Block For Butt End of Pole 1 Required Material-Pine
Stop Block 1 Required Material-Pine
Wedge in Position
At Butt Line
Butt of Pole
Splice
30' Length of Pole
30'10¼" Overall Length of Form
Top View
Drill & C'b'k for ⅝" Stove Bolts
⅜"x8"x36" St. Pl.
Top of Pole
Detail Splice
Note: Plate on Inside of Form to be Countersunk in Plank
Side Brace
Side Board
Rd.Hd.Bolt
Stop Block
Detail of Form at Butt
Side View
Form For Concrete Poles
New York State Railways Co.
Rochester, N.Y.

68c FIG. 7. FORM FOR CONSTRUCTION OF CONCRETE POLE, ROCHESTER, N. Y.

SAMPLES OF MATERIAL:

5. The Contractor shall supply, for the examination and approval of the Company, such test pieces as may be required of the material entering into the poles which he furnishes.

II. Construction of Poles

DESCRIPTION:

6. The poles shall be built to the dimensions shown on drawings or otherwise specified.

WEIGHTS:

7. Variations in weights of poles shall not exceed five (5) per cent. over or under the weights specified in the order.

FORMS:

8. Poles may be manufactured in wooden or steel forms, cast in horizontal position, and will require great care in handling during erection.

REINFORCEMENT:

9. The area of reinforcing rods shall constitute practically three (3) per cent. of the cross sectional area of the pole at the ground line, and shall be made up of sixteen(16) reinforcing bars placed as shown in Fig. No. ——. The modulus of elasticity of the reinforcing steel shall be at least 30,000,000.

POLE ATTACHMENTS:

10. Holes shall be provided in the pole for steps, cross-arms, span wire attachments, bracket arms and other fixtures.

CONCRETE:

11. The concrete shall be made of Portland cement meeting the test requirements of the American Society for Testing Materials, of clean, sharp sand, and crushed stone, which shall be clean and free from dust and not more than three-quarter (¾) inch in its largest dimension. Clean gravel of the same size may be used in place of stone. The mix shall be of a richness of at least 1 part cement, 2 parts sand, and 4 parts stone.

III. Tests

FACILITIES FOR TEST:

12. (*a*) The Contractor shall afford the Company all reasonable facilities at the point of manufacture to enable it to satisfy itself as to whether the poles conform to the requirements of this specification.

(*b*) If inspection at the point of manufacture is waived, the Contractor shall, if required by the Company, make the tests as hereinafter specified and forward a signed copy of the results to the Company.

TEST:

13. One (1) per cent of the number of poles (minimum of one pole) may be tested to destruction, and ten (10) per cent of the total number of poles may be tested for deflection with the specified loading. All at the expense of the Contractor. Any additional testing that may be required by the Company shall be at its expense. The poles to be tested may be selected by the Company.

IV. REJECTION

14. The failure of forty (40) per cent of the poles tested to meet the requirements as herein specified, shall be sufficient cause for rejection of the entire order.

TUBULAR STEEL POLES

In the 1913 report of the Committee on Power Distribution quite a full treatment was given of tubular steel poles. In that report tables and curves of stresses and sags in spans were given to enable the proper selection of poles to be made. A specification, tables of deflections and loads, and the derivation of the general formula for deflection was also given. In the 1914 report there was given an extension of the curves and tables of spans and sags.

In this report certain modifications of the specification, computed deflections, and pipe tables have been made. These will be treated in order and the reasons for the changes noted.

For each length of pole there should be one most economical length for each section of pipe, based upon standard mill lengths of pipe. The manufacturers are not agreed as to what these section lengths should be but will furnish any length desired. The lengths given in Table 1 are in common use and any company will furnish these, although they also will furnish other lengths as shown in their catalogs. The thicknesses and weights of pipe have now been agreed to by the pipe manufacturers as shown in Table II, p. 22. The modulus of elasticity of steel for pole purposes is pretty well settled at 29,000,000 and this value has been used in computing the deflections of Table I, p. 18. The method of computing these deflections is explained below, and the differences between the methods used by various manufacturers is also noted.

MODIFICATION OF SPECIFICATION FOR TUBULAR STEEL POLES *

The Specification for Tubular Steel Poles is given on page 84 of the 1913 Proceedings and in the Engineering Manual Ds 5a. The following modifications in that Specification are recommended:

For Section 8 substitute the following:

GROUND SLEEVES:

8. A ground sleeve shall be furnished, unless otherwise directed by the Company, with every pole. It shall be made of standard weight

*Formally approved by both the Committee on Standards and the 1915 Convention as Standard.

pipe two (2) feet in length and shall be shrunk on the butt section with the bottom of the sleeve five (5) feet and six (6) inches from the base of the pole, unless otherwise directed by the Company.

For Section 9 substitute the following:

JOINTS:

9. Joints shall be made by inserting the smaller pipe cold into the larger pipe a distance of 18 inches. The outer pipe may be swaged hot upon the inner or the outer pipe may be drawn hot or cold through a die. The thickness of the outside pipe shall not be reduced and the variation in outside diameter shall not be more than one-sixty-fourth (1/64) inch. No shims, liners, pins, rivets or any device that weakens the joint will be allowed. The top of the outer pipe shall be chamfered to shed water and the completed joint shall be water tight.

Add to Section 11 —

PAINTING:

11. The poles shall be painted and allowed to dry before loading on the cars for shipment.

Substitute for Section 14 —

DEFLECTION TESTS:

14. Any pole when fixed for a distance of six (6) feet from the butt end and tested as a cantilever with the load given in attached Table 1 applied eighteen (18) inches below the top, shall not show a permanent set or deflection, at the point of load, in excess of ten (10) per cent of the temporary deflection under this load, but this set limit may not be required to be less than one-half (½) inch in any case. The temporary deflection at the point of load, shall not exceed the limit specified in the table when subjected to the corresponding load.

Substitute for Table 1, 1913 Proceedings, pages 86–89 (Manual Ds 3a, Table 3) — "Deflections and Loads", the newly computed Table 1 shown on pp. 76–79.

Substitute for Table 2, 1913 Proceedings, page 90 (Manual Ds 3a, Table 4) — "Pipe Table", the newly computed Table II shown on pp. 80–81.

DERIVATION OF FORMULA FOR DEFLECTION OF TUBULAR STEEL POLES

In the 1913 report of the Committee on Power Distribution (page 81 of the 1913 Proceedings) there was given the derivation of the simple cantilever formula for computing deflections. It is believed that a more exact formula should be presented, inasmuch as the simple formula previously used applies strictly only to poles of uniform diameter. There is therefore presented here a formula which takes into consideration the fact that the poles are made up of two or three sections of different diameters instead of a uniform section. Referring to Fig. 8, we may derive the general formula for deflection as follows:

The general formula for internal moment in an elastic body is:

$$M = EI\frac{d^2y}{dx^2}$$

Where E is the modulus of elasticity of the material and I is the moment of inertia of cross section about the neutral axis. At any point (x, y) the bending moment, which must equal the above internal moment of resistance is $P(L—X)$, where P is the load applied and L is the distance of application of the load from the fixed end (O).

$$\text{Hence, } EI\frac{d^2y}{dx^2} = P\,(L—X)$$

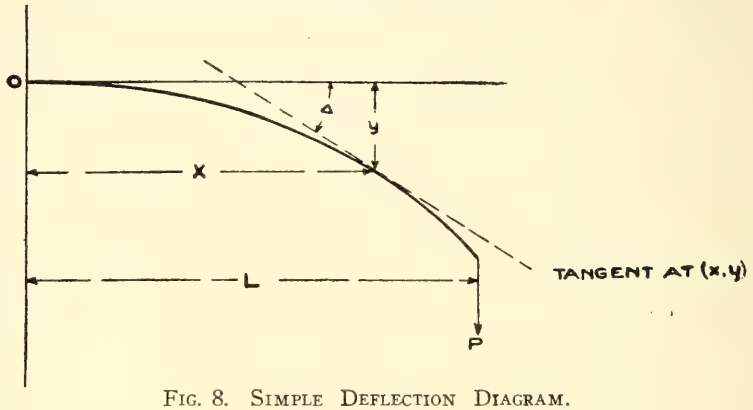


FIG. 8. SIMPLE DEFLECTION DIAGRAM.

Integrating and assuming I constant

$$EI\frac{dy}{dx} = P\left(Lx — \frac{X^2}{2}\right) + C$$

Now $\frac{dy}{dx}$ is the tangent of inclination, which at origin O is zero. At origin, X is also zero. Hence C must be zero.

Integrating again

$$EIy = P\left(\frac{Lx^2}{2} — \frac{x^3}{6}\right) + C$$

At origin, Y is zero and X is zero; hence C must be zero. We have, therefore, that the deflection at any point, (x, y) is

$$Y = \frac{P}{2EI}\left(Lx^2 — \frac{x^3}{3}\right)$$

and at point of application of load P where X becomes L,

$$Y = \frac{PL^3}{3EI}$$

which is the commonly used simple formula for deflection of a steel pole, Y and L being in inches and P in pounds and I the moment of inertia of the steel section.

This general formula is the equation of a parabolic curve.

The slope of a line tangent to this curve at any point (x, y) is obtained by differentiating the general equation. The slope is the tangent of the angle between the tangent line and the axis, as shown in Fig. 8. We thus have for the slope of a tangent to the curve—

$$\text{Tan } \triangle = \frac{dy}{dx} = \frac{P}{EI}\left(Lx - \frac{X^2}{2}\right)$$

We may now apply these general formulæ to the particular case of computing the deflection in a three section tubular steel pole set 6 ft. in ground and with load applied 18 in. from top, and pipe insertion of 18 in.

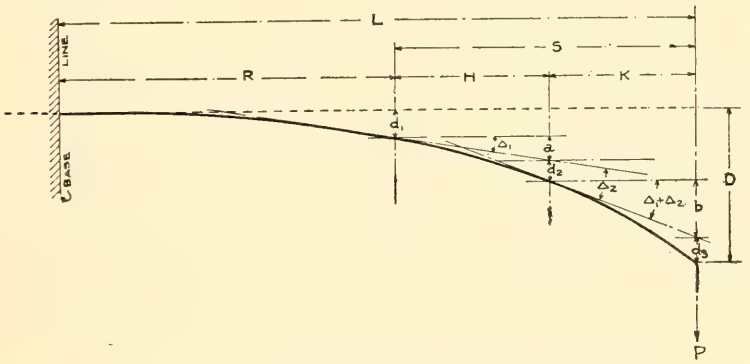


FIG. 9. THREE-SECTION DEFLECTION DIAGRAM.

Referring to Fig. 9 we have the following notation:

R = length of butt section above ground line or length of butt minus 6 ft.

H = length of middle section from end of butt section to top of middle section or length of middle minus 1½ ft.

K = length of top section from top of middle section to point of application of load, 18 in. from top end of pole, or length of end section minus 3 ft.

S = the sum of H and K.

L = the total length of pole between ground line and point of application of load, or total length of pole minus 7 ft. 6 in.

P = pull in pounds applied as load tending to bend the pole.

d_1, d_2, d_3 = deflections occurring in the butt, middle and top sections respectively.

D = total deflection at point of application of pull produced by pull P.

E = modulus of elasticity of steel used in pole—assumed to be 29,000,000.

I_1, I_2, I_3 = moments of inertia of butt, middle and top sections of pole.

$\triangle_1$, $\triangle_2$, angles between tangents to curve and original position of pole.

In the derivation two assumptions have been made:

1. All deflections (d_1, d_2, d_3) are measured as parallel and at right angles to original position of pole.

2. The deflections are small and hence we may say —

$$\tan\ (\triangle_1 + \triangle_2) = \tan \triangle_1 + \tan \triangle_2$$

The total deflection (D) is made up of —

(1) The actual deflections in the three sections (d_1, d_2, d_3);

(2) The deviations (a, b) from the original position caused by the deflection of the lower sections of the pole and measured on the perpendicular to the original position.

The total deflection is then:

$$D = d_1 + a + d_2 + b + d_3$$

and substituting from the geometrical properties of Fig. 9,

$$D = d_1 + H \tan \triangle_1 + d_2 + K \tan (\triangle_1 + \triangle_2) + d_3.$$

$$= d_1 + H \tan \triangle_1 + d_2 + K (\tan \triangle_1 + \tan \triangle_2) + d_3.$$

Making further substitutions from the general formulæ above for deflections and tangents and reducing we get —

$$D = \frac{1728\ P}{6E}\left[\frac{R^2\,(2L+S) + 3RS\,(L+S)}{I_1} + \frac{3H\,(S^2+K^2) - H^3}{I_2} + \frac{2K^3}{I_3}\right]$$

It is desirable to express R, H, K and S in feet and the factor 1728 is introduced to enable these values to be expressed in feet and the resulting deflection (D) in inches. Inasmuch as all the terms in the above equation are of the third degree this necessitates the use of a reduction factor equal to the cube of 12.

The Table 1 was computed from the above formula.

If it is desired to compute the deflection for a *two section pole* the middle term above may be omitted.

Computation of Table of Pole Deflections and Comparison of Deflections Computed by Different Methods

The accompanying curve sheet (Fig. 10) shows graphically the differences in the computed deflections when different formulæ are used. One company uses the simple cantilever formula, which results in a computed deflection somewhat less than would actually be secured under test. The other company uses a method of computation involving some constants which have the effect of allowing a factor of safety. The formula used by the Committee (the middle curve) is more exact than the simple formula and is the one from which Table 1 was computed, but no factor of safety has been used. It is believed it would be more satisfactory to record the actual computed deflections and allow each company to choose the desired factor of safety. The resulting deflection would be of course that given in Table 1 multiplied by the chosen factor of safety. The poles selected for comparison are all of standard weights and as near comparable as could be selected from the catalogs. The deflections of one company average 15.7 per cent above and of the other 5.95 per cent below the deflections computed by the Committee.

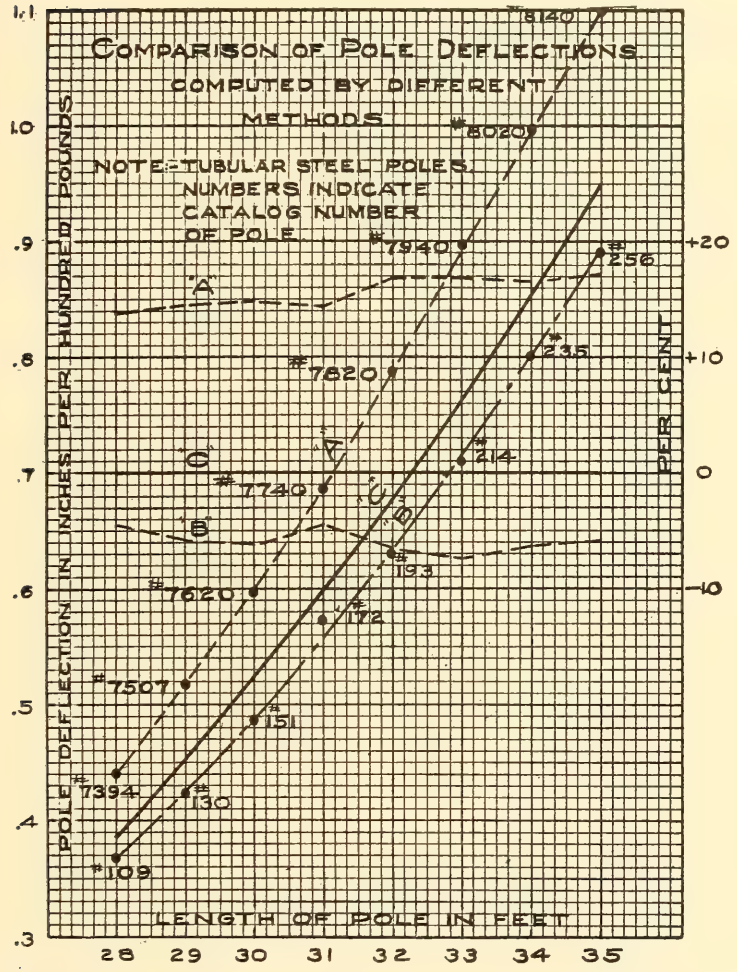


FIG. 10. COMPARISON OF POLE DEFLECTIONS COMPUTED BY DIFFERENT METHODS.

PIPE TABLE

Table II is a modified form of that appearing on page 90 of the 1913 Proceedings, and in *Engineering Manual* Ds 3a, page 18. A revision was made necessary because of some changes in the pipe dimensions. The manufacturers of pipe have standardized their sections and the thicknesses and weights are now as given in Table II. In computing the moment of resistance a maximum fibre stress of 20,000 lb. has been used. This may safely be increased somewhat if desired.

Table I — Tubular Steel Poles — Deflections and Loads*

Length of pole	Description of poles: Size and kind of pipe: Butt: Standard	Butt: Extra heavy	Middle: Standard	Top: Standard	Weight of pole	Section lengths: Butt	Middle	Top	Pole set 6′ 0″ in ground — load applied and deflection measured 18″ from free end, probable deflections when held and loaded as stated: Load in pounds applied 18″ from free end of pole: 100	500	600	800	1,000	1,200	1,400	1,600	1,800	2,100	2,400	2,700	3,000	Greatest safe load	Length of pole
(Ft.)					(Lbs.)	(Feet)	(Feet)	(Feet)	(In.)	(In.)	(In.)	(In.)	(In.)	(In.)	(In.)	(In.)	(In.)	(In.)	(In.)	(In.)	(In.)	(Lbs.)	(Ft.)
28	5	.....	4	3	385	18	7	6	1.23	....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	443	28
28	.....	5	4	3	495	18	7	6	.90	4.52	5.42	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	603	28
28	6	.....	5	4	509	18	7	6	.65	3.24	3.89	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	692	28
28	.....	6	5	4	681	18	7	6	.46	2.28	2.73	3.64	.....	.....	.....	.....	.....	.....	.....	.....	.....	993	28
28	7	.....	6	5	645	18	7	6	.39	1.93	2.32	3.09	.....	.....	.....	.....	.....	.....	.....	.....	.....	992	28
28	.....	7	6	5	906	18	7	6	.26	1.27	1.53	2.04	2.55	3.06	3.57	.....	.....	.....	.....	.....	.....	1,525	28
28	8	.....	7	6	791	18	7	6	.25	1.23	1.48	1.98	2.47	2.97	.....	.....	.....	.....	.....	.....	.....	1,366	28
28	.....	8	7	6	1,058	18	7	6	.17	.84	1.01	1.34	1.68	2.02	2.35	2.69	3.03	.....	.....	.....	.....	1,990	28
28	9	.....	8	7	951	18	7	6	.17	.83	.99	1.32	1.65	1.98	2.31	2.64	2.97	.....	.....	.....	.....	1,817	28
28	.....	9	8	7	1,218	18	7	6	.12	.59	.71	.94	1.18	1.42	1.65	1.89	2.12	2.48	2.83	.....	.....	2,527	28
28	10	.....	9	8	1,137	18	7	6	.11	.57	.68	.90	1.13	1.36	1.58	1.81	2.04	2.37	2.71	.....	.....	2,432	28
28	.....	10	9	8	1,393	18	7	6	.08	.41	.50	.66	.83	1.00	1.16	1.33	1.49	1.74	1.99	2.24	2.49	3,205	28
29	5	.....	4	3	393	18	7	7	1.45	....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	422	29
29	.....	5	4	3	503	18	7	7	1.07	5.35	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	575	29
29	6	.....	5	4	520	18	7	7	.76	3.83	4.58	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	658	29
29	.....	6	5	4	692	18	7	7	.54	2.67	3.21	4.28	.....	.....	.....	.....	.....	.....	.....	.....	.....	947	29
29	7	.....	6	5	659	18	7	7	.45	2.26	2.72	3.63	.....	.....	.....	.....	.....	.....	.....	.....	.....	946	29
29	.....	7	6	5	920	18	7	7	.30	1.49	1.79	2.38	2.98	3.58	4.17	.....	.....	.....	.....	.....	.....	1,450	29
29	8	.....	7	6	811	18	7	7	.29	1.44	1.73	2.31	2.88	3.46	.....	.....	.....	.....	.....	.....	.....	1,304	29
29	.....	8	7	6	1,078	18	7	7	.20	.98	1.18	1.57	1.96	2.35	2.74	3.14	3.53	.....	.....	.....	.....	1,900	29
29	9	.....	8	7	974	18	7	7	.19	.96	1.15	1.54	1.92	2.30	2.69	3.07	.....	.....	.....	.....	.....	1,733	29
29	.....	9	8	7	1,241	18	7	7	.14	.69	.82	1.09	1.37	1.64	1.92	2.19	2.46	2.88	3.29	.....	.....	2,410	29
29	10	.....	9	8	1,166	18	7	7	.13	.65	.77	1.03	1.29	1.55	1.81	2.06	2.32	2.71	.....	.....	.....	2,320	29
29	.....	10	9	8	1,422	18	7	7	.10	.48	.58	.78	.97	1.16	1.36	1.55	1.74	2.04	2.33	2.62	2.91	3,060	29

30	5	.....	4	3	406	18	9	6	1.67	....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	403	30
30	.....	5	4	3	516	18	9	6	1.23	6.16	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	550	30
30	6	.....	5	4	539	18	9	6	.88	4.39	5.27	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	629	30
30	.....	6	5	4	711	18	9	6	.62	3.08	3.70	4.93	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	906	30
30	7	.....	6	5	682	18	9	6	.52	2.60	3.12	4.17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	903	30
30	.....	7	6	5	943	18	9	6	.34	1.71	2.06	2.74	3.43	4.12	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,387	30
30	8	.....	7	6	840	18	9	6	.33	1.65	1.99	2.65	3.31	3.97	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,245	30
30	.....	8	7	6	1,107	18	9	6	.23	1.12	1.35	1.80	2.25	2.70	3.15	3.60	4.05	.....	.....	.....	.....	.....	.....	1,815	30
30	9	.....	8	7	1,008	18	9	6	.22	1.10	1.33	1.77	2.21	2.65	3.09	3.54	.....	.....	.....	.....	.....	.....	.....	1,655	30
30	.....	9	8	7	1,275	18	9	6	.16	.79	.95	1.26	1.58	1.90	2.21	2.53	2.85	3.32	.....	.....	.....	.....	.....	2,305	30
30	10	.....	9	8	1,205	18	9	6	.15	.74	.89	1.18	1.48	1.78	2.07	2.37	2.66	3.11	.....	.....	.....	.....	.....	2,220	30
30	.....	10	9	8	1,461	18	9	6	.11	.56	.67	.90	1.12	1.34	1.57	1.79	2.02	2.35	2.69	3.02	.....	.....	.....	2,920	30
31	5	.....	4	3	413	18	9	7	1.95	....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	387	31
31	.....	5	4	3	523	18	9	7	1.44	7.18	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	527	31
31	6	.....	5	4	549	18	9	7	1.02	5.09	6.12	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	603	31
31	.....	6	5	4	721	18	9	7	.72	3.58	4.29	5.72	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	867	31
31	7	.....	6	5	696	18	9	7	.60	3.00	3.60	4.80	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	865	31
31	.....	7	6	5	958	18	9	7	.40	1.98	2.38	3.18	3.97	4.77	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,325	31
31	8	.....	7	6	860	18	9	7	.38	1.90	2.29	3.05	3.81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,192	31
31	.....	8	7	6	1,127	18	9	7	.26	1.30	1.55	2.07	2.59	3.11	3.63	4.15	.....	.....	.....	.....	.....	.....	.....	1,740	31
31	9	.....	8	7	1,031	18	9	7	.25	1.27	1.52	2.03	2.54	3.05	3.56	.....	.....	.....	.....	.....	.....	.....	.....	1,585	31
31	.....	9	8	7	1,299	18	9	7	.18	.91	1.09	1.46	1.82	2.18	2.55	2.91	3.28	3.82	.....	.....	.....	.....	.....	2,205	31
31	10	.....	9	8	1,234	18	9	7	.17	.85	1.02	1.36	1.70	2.04	2.38	2.72	3.06	3.57	.....	.....	.....	.....	.....	2,125	31
31	.....	10	9	8	1,491	18	9	7	.13	.64	.77	1.02	1.28	1.54	1.79	2.05	2.31	2.69	3.07	3.45	.....	.....	.....	2,795	31
32	5	.....	4	3	427	19	9	7	2.17	....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	371	32
32	.....	5	4	3	545	19	9	7	1.61	8.02	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	505	32
32	6	.....	5	4	568	19	9	7	1.14	5.70	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	578	32
32	.....	6	5	4	749	19	9	7	.80	4.01	4.82	6.42	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	832	32
32	7	.....	6	5	720	19	9	7	.68	3.37	4.05	5.40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	830	32
32	.....	7	6	5	995	19	9	7	.45	2.22	2.67	3.56	4.45	5.33	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,275	32
32	8	.....	7	6	888	19	9	7	.43	2.14	2.57	3.43	4.28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,143	32
32	.....	8	7	6	1,169	19	9	7	.29	1.46	1.75	2.33	2.92	3.50	4.08	4.67	.....	.....	.....	.....	.....	.....	.....	1,665	32
32	9	.....	8	7	1,066	19	9	7	.29	1.43	1.72	2.29	2.86	3.43	4.00	.....	.....	.....	.....	.....	.....	.....	.....	1,520	32
32	.....	9	8	7	1,348	19	9	7	.20	1.02	1.22	1.63	2.04	2.45	2.85	3.27	3.67	4.28	.....	.....	.....	.....	.....	2,115	32
32	10	.....	9	8	1,274	19	9	7	.19	.96	1.15	1.53	1.92	2.30	2.69	3.07	3.46	.....	.....	.....	.....	.....	.....	2,035	32
32	.....	10	9	8	1,545	19	9	7	.14	.72	.86	1.15	1.44	1.73	2.02	2.31	2.59	3.03	3.45	.....	.....	.....	.....	2,680	32

TABLE I — TUBULAR STEEL POLES — DEFLECTIONS AND LOADS — (*continued*)

Length of pole	Description of poles: Size and kind of pipe: Butt: Standard	Butt: Extra heavy	Middle: Standard	Top: Standard	Weight of pole	Section lengths: Butt	Middle	Top	Pole set 6′ 0″ in ground — load applied and deflection measured 18″ from free end, probable deflections when held and loaded as stated: Load in pounds applied 18″ from free end of pole: 100	500	600	800	1,000	1,200	1,400	1,600	1,800	2,100	2,400	2,700	3,000	Greatest safe load	Length of pole
(*Ft.*)					(*Lbs.*)	(*Feet*)	(*Feet*)	(*Feet*)	(*In.*)	(*In.*)	(*In.*)	(*In.*)	(*In.*)	(*In.*)	(*In.*)	(*In.*)	(*In.*)	(*In.*)	(*In.*)	(*In.*)	(*In.*)	(*Lbs.*)	(*Ft.*)
33	5	.....	4	3	439	19	10	7	2.48	....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	357	33
33	.....	5	4	3	555	19	10	7	1.83	....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	487	33
33	6	.....	5	4	582	19	10	7	1.30	6.49	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	555	33
33	.....	6	5	4	764	19	10	7	.91	4.56	5.47	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	798	33
33	7	.....	6	5	739	19	10	7	.77	3.83	4.60	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	797	33
33	.....	7	6	5	1,015	19	10	7	.51	2.53	3.04	4.05	5.07	6.08	.....	.....	.....	.....	.....	.....	.....	1,225	33
33	8	.....	7	6	910	19	10	7	.49	2.43	2.92	3.89	4.87	.....	.....	.....	.....	.....	.....	.....	.....	1,098	33
33	.....	8	7	6	1,192	19	10	7	.33	1.65	1.99	2.65	3.31	3.97	4.63	5.30	.....	.....	.....	.....	.....	1,605	33
33	9	.....	8	7	1,094	19	10	7	.33	1.62	1.95	2.60	3.25	3.90	4.55	.....	.....	.....	.....	.....	.....	1,460	33
33	.....	9	8	7	1,376	19	10	7	.23	1.16	1.39	1.86	2.32	2.78	3.25	3.71	4.18	.....	.....	.....	.....	2,035	33
33	10	.....	9	8	1,308	19	10	7	.22	1.09	1.31	1.74	2.18	2.62	3.05	3.49	3.93	.....	.....	.....	.....	1,955	33
33	.....	10	9	8	1,579	19	10	7	.16	.82	.98	1.31	1.64	1.97	2.30	2.63	2.95	3.28	3.94	.....	.....	2,580	33
34	5	.....	4	3	454	20	10	7	2.75	....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	343	34
34	.....	5	4	3	575	20	10	7	2.03	....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	467	34
34	6	.....	5	4	601	20	10	7	1.44	7.21	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	534	34
34	.....	6	5	4	792	20	10	7	1.01	5.08	6.09	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	768	34
34	7	.....	6	5	763	20	10	7	.86	4.28	5.13	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	767	34
34	.....	7	6	5	1,053	20	10	7	.56	2.81	3.37	4.49	5.62	.....	.....	.....	.....	.....	.....	.....	.....	1,177	34
34	8	.....	7	6	939	20	10	7	.54	2.71	3.25	4.33	5.42	6.51	.....	.....	.....	.....	.....	.....	.....	1,057	34
34	.....	8	7	6	1,235	20	10	7	.37	1.85	2.22	2.96	3.70	4.44	5.18	.....	.....	.....	.....	.....	.....	1,543	34
34	9	.....	8	7	1,128	20	10	7	.36	1.81	2.17	2.89	3.62	4.34	5.07	.....	.....	.....	.....	.....	.....	1,405	34
34	.....	9	8	7	1,425	20	10	7	.26	1.29	1.55	2.07	2.59	3.11	3.63	4.15	4.67	.....	.....	.....	.....	1,955	34
34	10	.....	9	8	1,348	20	10	7	.24	1.21	1.45	1.93	2.42	2.90	3.39	3.87	4.36	.....	.....	.....	.....	1,885	34
34	.....	10	9	8	1,634	20	10	7	.18	.92	1.10	1.46	1.83	2.20	2.56	2.93	3.29	3.84	4.39	.....	.....	2,480	34

35	5	.....	4	3	469	21	10	7	3.03	....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	..331	35
35	.....	5	4	3	595	21	10	7	2.23	....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	450	35
35	6	.....	5	4	620	21	10	7	1.59	7.97	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	515	35
35	.....	6	5	4	820	21	10	7	1.12	5.60	6.72	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	741	35
35	7	.....	6	5	787	21	10	7	.95	4.73	5.68	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	738	35
35	.....	7	6	5	1,091	21	10	7	.62	3.12	3.75	4.99	6.24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,135	35
35	8	.....	7	6	968	21	10	7	.60	3.01	3.61	4.82	6.02	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,018	35
35	.....	8	7	6	1,278	21	10	7	.41	2.05	2.46	3.28	4.10	4.92	5.74	.....	.....	.....	.....	.....	.....	.....	.....	1,485	35
35	9	.....	8	7	1,162	21	10	7	.40	2.01	2.41	3.22	4.02	4.82	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,355	35
35	.....	9	8	7	1,474	21	10	7	.29	1.43	1.72	2.29	2.87	3.44	4.02	4.59	5.17	.....	.....	.....	.....	.....	.....	1,885	35
35	10	.....	9	8	1,388	21	10	7	.27	1.35	1.62	2.16	2.70	3.24	3.78	4.32	4.87	.....	.....	.....	.....	.....	.....	1,818	35
35	.....	10	9	8	1,689	21	10	7	.20	1.01	1.21	1.62	2.02	2.42	2.83	3.23	3.64	4.24	.....	.....	.....	.....	.....	2,390	35

Formally approved by both the Committee on Standards and the 1915 Convention as Standard.

TABLE II —

NOMINAL DIAMETER IN INCHES	3		4		5	
	Standard	Extra heavy	Standard	Extra heavy	Standard	Extra heavy
Weight of pipe, pounds per foot	7.575	10.252	10.790	14.983	14.617	20.778
Actual diameter, inches						
External = D	3.500	3.500	4.500	4.500	5.563	5.563
Internal = d	3.068	2.900	4.026	3.826	5.047	4.813
Thickness	.216	.300	.237	.337	.258	.375
Circumference, inches						
External	10.996	10.996	14.137	14.137	17.477	17.477
Internal	9.638	9.111	12.648	12.020	15.856	15.120
Transverse areas, square inches						
External	9.621	9.621	15.904	15.904	24.306	24.306
Internal	7.393	6.605	12.730	11.497	20.006	18.193
Metal	2.228	3.016	3.174	4.407	4.300	6.113
Moment of inertia = I $I = .0491\ (D^4 - d^4)$	3.017	3.894	7.233	9.610	15.162	20.671
Modulus of section = S $S = .0982 \left(D^3 - \frac{d^4}{D}\right) = \frac{2I}{D}$	1.724	2.225	3.214	4.271	5.451	7.432
R = Moment of resistance Inch pounds $R = S\ F$ (F = 20,000 lb. sq. in.)	34,480	44,500	64,280	85,420	109,020	148,640

* Formally approved by both the Committee on Standards and the 1915 Convention as Standard.

PIPE TABLE*

6		7		8		9		10	
Standard	Extra heavy	Standard	Extra heavy	Standard	Extra heavy	Standard	Extra heavy	Standard	Extra heavy
18.974	28.573	23.544	38.048	28.554	43.388	33.907	48.728	40.483	54.735
6.625	6.625	7.625	7.625	8.625	8.625	9.625	9.625	10.750	10.750
6.065	5.761	7.023	6.625	7.981	7.625	8.941	8.625	10.020	9.750
.280	.432	.301	.500	.322	.500	.342	.500	.365	.500
20.813	20.813	23.955	23.955	27.096	27.096	30.238	30.238	33.772	33.772
19.054	18.099	22.063	20.813	25.073	23.955	28.089	27.096	31.479	30.631
34.472	34.472	45.664	45.664	58.426	58.426	72.760	72.760	90.763	90.763
28.891	26.067	38.738	34.474	50.027	45.666	62.786	58.430	78.853	74.663
5.581	8.405	6.926	11.190	8.399	12.760	9.974	14.33	11.91	16.10
28.140	40.491	46.515	71.370	72.489	105.720	107.580	149.63	160.73	211.95
8.496	12.224	12.201	18.720	16.809	24.505	22.354	31.092	29.917	39.433
169,920	244,480	244,020	374,400	336,180	490,100	447,080	621,840	598,340	788,660

SPECIFICATIONS FOR SUNDRY LINE MATERIALS

The Sub-committee on Overhead Line Material Standardization was appointed by the 1911 Committee on Power Distribution (1911 Proceedings, page 86). The subject was continued by the 1912 Committee which submitted several specifications for criticism and comment for the guidance of future Committees (1912 Proceedings, pages 111, 150–172). Due either to the excellence of the specifications then submitted or to lack of interest in the subject, no comment or criticism was received from any of the Association membership. The 1913 Committee further considered the subject (1913 Proceedings, page 57), as did the 1914 Committee (1914 Proceedings, pages 32, 33), but both Committees recommended that they be given more time to investigate. The present Sub-committee has given this subject an extended consideration and has had the benefit of all of the work of preceding Committees as noted above, and as a result your Committee submits, with a recommendation that there be adopted as Recommended Specification, the following "General Requirements" and Specifications for "Iron and Steel Fittings" and "Wood Cross Arms."

SPECIFICATIONS FOR OVERHEAD LINE MATERIAL*

GENERAL REQUIREMENTS

QUALITY OF MATERIAL:

1. All material must be at least of the best commercial quality, both as to stock and as to finish.

GENERAL WORKMANSHIP:

2. The general workmanship must be appropriate to the service for which the article is designed. All material must have, on surfaces not in contact, at least such finish as results from good commercial practice in its manufacture; surfaces to be protected must be of a character to properly receive and retain the protective coat.

Fixed contact surfaces must be so finished as to give good bearing unless better is specified.

Moving contacts must be suitably finished for the particular service.

GENERAL DESIGN:

3. Where latitude is allowed in design, strength, lightness, and simplicity must be the ruling considerations.

Where possible, parts must be of such relation, and sufficiently true to size and shape to permit, if necessary, their removal and replacement without injury to other parts.

DRAWINGS:

4. Drawings which accompany these specifications must be considered a part of the text.

* Formally approved by both the Committee on Standards and the 1915 Convention as a Recommended Specification.

CASTINGS:

5. Castings must be true to pattern. Inside corners must be filleted, and in the absence of specific details, sections must be such as to give maximum strength and avoid shrinkage strains.

PROTECTION:

6. All metal fittings of material subject to corrosion where used, must have an approved protection, which must be firmly adherent, uniform and smooth. Threads and other moving contacts of such fittings must have full protection without interference with use, and members of such fittings which may be subjected to bending must have a protection which will not be injuriously affected by such treatment.

All zinc protective coatings must be in accordance with the Standard Specification of the American Electric Railway Engineering Association.

REJECTION:

7. Material may be tested by representative samples taken at random from each shipment; failure of such sample or samples will be cause for rejection of the shipment, and its return from point of delivery, the contractor paying transportation charges both ways.

Material which fails within one year after acceptance by reason of inherent defects must be replaced by the contractor at his expense.

METHOD OF SHIPMENT:

8. Material must be shipped in such manner as to ensure its receipt without loss or injury and to permit of further handling if necessary. Small stock must be securely bundled, bagged, boxed, barrelled or crated; insulators must be well packed in hay or equivalent.

Unless otherwise specified, wire in sizes smaller than one-nought (1/0) may be shipped on reels or in protected coils; one-nought (1/0) and larger must be shipped on reels of sufficient diameter to prevent sharp bends and so built and of sufficient strength to permit mounting and using on an arbor.

IRON AND STEEL FITTINGS

GENERAL DESCRIPTION:

9. Anchor rods, bolts of all kinds, braces, guy hooks, lag screws, support rods and pole steps must be of standard wrought iron or mild steel; guy clamps, metal insulator pins and pole bands may be of standard wrought iron, mild steel, or malleable iron as specified. All castings such as bracket fittings, mechanical ears, hanger shells, pullovers, strain plates, and other castings subject to tensile or bending stresses must be of malleable iron or its equivalent. Guy plates, hub guards, thimbles and washers may be of commercial grade of iron or steel. Bracket arms may be of commercial pipe or tubing.

I. Standard* Wrought Iron and Mild Steel

CHARACTER:

10. (*a*) All standard* wrought iron and mild steel must comply with the current specifications of the American Society for Testing Materials for "Refined Wrought Iron Bars" or for "Structural Steel for Buildings."

(*b*) Welds and upsets must be free from cracks, flaws, burned metal or crystallization and must develop the full strength of the normal section.

THREADS:

11. (*a*) Threads may be cut or rolled unless one is specified. Bolts and rods must have United States Standard thread and pitch; lag screws and pole steps may have either fetter or twist threads unless one is specified.

(*b*) All threads must be full, clean and concentric with shank; if used with nut, end must permit running on readily.

NUTS:

12. Nuts must be square, symmetrically formed, with hole central and at right angles to face, tapped to fit corresponding thread so they can be run readily the entire length by the fingers without noticeable play or rocking.

ANCHOR BOLTS:

13. (*a*) Guy anchor bolts, for general use in rock, must be one (1) inch diameter, eighteen (18) inches long, with eye one (1) inch inside radius. (See Fig. 11.)

(*b*) Guy anchor bolts of wedge type, for use in hard rock, must consist of a central rectangular bar, one-and-one-quarter (1¼) inches wide, three-fourths (¾) inches thick, and six-and-one-half (6½) inches long; and two outside pieces, each nine-and-one-half (9½) inches long, of which six-and-one-half (6½) inches is a wedge one-and-one-fourth (1¼) inches wide, three-fourths (¾) inch thick at base, three-eighths (⅜) inch thick at top, outer surface an arc of circle three-fourths (¾) inch radius, and inner face a plane. Above wedge the section must expand into eye two (2) inches diameter with hole eleven sixteenths (11/16) inch diameter. Each anchor must be furnished with five-eighths (⅝) inch diameter machine bolt two-and-five-sixteenths (2 5/16) inches long under head, with square nut. (See Fig. 11.)

ANCHOR RODS:

14. Guy anchor rods, for use in earth, must have at upper end an eye capable of developing full strength of rod; with lower end threaded and furnished with nut and washer as per table. (See Fig. 11.)

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* The word "standard" is here used to distinguish this class of material, which must conform to A. S. T. M. specifications, from "Commercial Steel and Iron," page 33.

Diameter of Rod	Length over all	Inside radius of eye	Washer
5/8"	6′ 0″	7/16″	3″ x 3″ x 3/16″
5/8"	8′ 0″	7/16″	3″ x 3″ x 3/16″
1/2"	6′ 0″	1/2″	3″ x 3″ x 3/16″
1/2"	8′ 0″	1/2″	3″ x 3″ x 3/16″
1"	10′ 0″	11/16″	4″ x 4″ x 1/2″

CARRIAGE BOLTS:

15. (*a*) Carriage bolts for fastening strap braces to cross arms must be three-eighths (3/8) inch diameter, with length under head three-fourths (3/4) inch greater than *width* of arm; for fastening angle braces and extension fixtures, one-half (1/2) inch diameter. Angle brace and strut bolts must have length under head three-fourths (3/4) inch greater than *depth* of arm, spreader bolts, three-fourths (3/4) inch greater than *width* of arm.

(*b*) In all cases bolts must be threaded at least one-and-one-quarter (1 1/4) inches and furnished with one (1) nut. (See Fig. 12.)

COTTER BOLTS:

16. Cotter bolts, for use in the clevises of pull-over bodies and strain insulators may have square or button heads, but shank must be seven-sixteenths (7/16) inch diameter, with one-and-one-half (1 1/2) inches clear between head and spring cotter, and at least one-sixteenth (1/16) inch of solid metal between hole and bolt end. Each cotter bolt must be furnished with one (1) spring cotter one-eighth (1/8) inch diameter not less than three-fourths (3/4) inch long under head. (See Fig. 12.)

EYE BOLTS:

17. (*a*) Eye bolts, for pole and bracket spans must have closed eye of one-half (1/2) inch inside radius, be threaded at least four (4) inches, and be of length specified. (See Fig. 12.)

(*b*) For pole spans diameter of shank must be five-eighths (5/8) inch, for bracket spans, one-half (1/2) inch. Each must be furnished with one (1) nut and one (1) round washer. (See Fig. 12.)

SPACING BOLTS:

18. Spacing bolts for use in double arm construction must be five-eighths (5/8) inch diameter, of length specified, threaded except for central portion not over four (4) inches long, and furnished with four (4) nuts and four (4) round washers. (See Fig. 12.)

TAP BOLTS:

19. Tap bolts for use with strain plates, pull-over bodies, and feed-in hangers must be five-eighths (5/8) inch diameter with square head, threaded at least three-fourths (3/4) of length, and used with one-eighth (1/8) inch thick lock washer. (See Fig. 12.)

Standard lengths under head are:

(*a*) For strain plates one-and-one-quarter (1¼) inches.

(*b*) For pull over bodies two-and-one-quarter (2¼) inches.

(*c*) For feed in hangers one-and-three-quarters (1¾) inches.

THROUGH BOLTS:

20. Through bolts for attaching cross arms to poles must be five-eighths (⅝) inch diameter, of length specified, threaded not less than four (4) inches and furnished with one (1) nut. (See Fig. 12.)

ANGLE BRACES:

21. (*a*) Angle braces, for heavy cross arm service must be open U-shape, bent from two (2) inch by two (2) inch by three-sixteenths (3/16) inch thick angle with vertical leg outside and having horizontal ends three (3) inches long, each with nine-sixteenths (9/16) inch hole with center one-and-one-half (1½) inches from end and three-fourths (¾) inch from outer edge of horizontal leg, and a curved central portion with eleven-sixteenths (11/16) inch hole in middle, three-fourths (¾) inch from outer edge in vertical leg.

(*b*) Short braces must be forty-five (45) inches long over all, with drop from line between tops of ends to top of center twelve (12) inches. (See Fig. 12.)

(*c*) Long brace must be sixty-three (63) inches long over all, with drop of eighteen (18) inches. (See Fig. 12.)

EXTENSION BRACES:

22. (*a*) Extension braces, consisting of strut and for more than one (1) arm, one (1) or more spreaders, must be two (2) inches by two (2) inches by three-sixteenths (3/16) inch angle. (See Fig. 13.)

(*b*) Strut must have three (3) inches at each end bent at angle of one hundred and thirty-five (135) degrees with main portion, the leg bent flatwise being outside and having hole with center three-fourths (¾) inch from edge and one and one-half (1½) inches from end, at each end; one (1) hole nine-sixteenths (9/16) inch diameter; the other eleven-sixteenths (11/16) inch diameter.

(*c*) Strut lengths, measured between bends, must be:

Type of Arm	Offset from center	Strut length bend to bend
4 pin	1 pin	45 inches
4 pin	2 pin	60 inches
6 or 8 pin	1 pin	60 inches
6 or 8 pin	2 pin	75 inches
6 or 8 pin	3 pin	90 inches
8 pin	4 pin	105 inches

(*d*) Spreader must have nine-sixteenths (9/16) inch diameter holes with centers three-fourths (¾) inch from edge and twenty-four (24) inches apart, in one (1) leg, end holes being one and one-half (1½) inches from end. (See Fig. 13.)

(*e*) Spreader lengths must be:

for 2 arms 27 inches.
3 arms 51 inches.
4 arms 75 inches.
5 arms 99 inches.

STRAP BRACES:

23. (*a*) Strap braces, for light cross-arm service, must be one and one-fourth (1¼) inches wide and one-fourth (¼) inch thick with holes one (1) inch from each end on center line, one (1) hole seven-sixteenths (7/16) inch diameter the other nine-sixteenths (9/16) inch diameter. (See Fig. 13.)

(*b*) Short brace must be twenty (20) inches long over all; long brace thirty (30) inches long over all.

GUY CLAMPS:

24. (*a*) Guy clamps must have over all length between five (5) inches and six (6) inches; width one and nine-sixteenths (1 9/16) inches, each half three-eighths (⅜) inch thick with three (3) bolt holes on center line, end holes with centers at least three-fourths (¾) inch from ends, those in head side oval, twenty-five thirty-seconds (25/32) inch lengthwise of clamp and nineteen thirty-seconds (19/32) inch wide; those on nut side nineteen thirty-seconds (19/32) inch diameter; each half having midway between bolt holes and side wavy grooves which must register and securely hold guys of from one-fourth (¼) inch to three-eighths (⅜) inch diameter. (See Fig. 14.)

(*b*) Each clamp must be furnished with three (3) button head bolts each one and five-eighths (1⅝) inches long under head with oval neck eleven-sixteenths (11/16) inch by one-half (½) inch by one-fourth (¼) inch long, remainder one-half (½) inch diameter, threaded at least one and three-sixteenths (1 3/16) inches and fitted with nut.

GUY HOOKS:

25. (*a*) Guy hooks may have oval section one and three-quarters (1¾) inches wide or rectangular section one and one-half (1½) inches wide, but in either case must be three-eighths (⅜) inch thick, five and one-half (5½) inches long, with hole eleven-sixteenths (11/16) inch diameter on center line one (1) inch from upper end, and lower part bent through one hundred and eighty (180) degrees to inside radius of three-eighths (⅜) inch so that hook is four (4) inches long over all. (See Fig. 14.)

(*b*) If of rectangular stock edges of hook must be rounded on inside to radius of two (2) inches, to prevent injury to strand.

LAG SCREWS:

26. Lag screw heads must be square, symmetrically formed and square with shank; three-fourths (¾) inch side by three-eighths (⅜) inch thick, shank one-half (½) inch diameter, four and one-half (4½) inches long under head, with at least three (3) inches threaded. (See Fig. 14.)

OVER SUPPORT RODS:

27. (*a*) Over support rods for brackets not over twelve (12) feet long must be one-half (½) inch diameter, threaded six (6) inches at one end and three (3) inches at other, and fitted with two (2) nuts and one (1) round washer. (See Fig. 14.)

(*b*) For tube nine (9) feet six (6) inches long rod must be eleven (11) feet four (4) inches in length; for other lengths up to twelve (12) feet, rod must be one and five one-hundredths (1.05) times tube length, plus one (1) foot four (4) inches.

(*c*) For lengths over twelve (12) feet over support will be special.

POLE BANDS:

28. (*a*) Pole bands for use on steel pole must be two (2) part clamping type, with inside radius that of pole section on which used, each part one and one-fourth (1¼) inches wide and three-sixteenths (3/16) inch thick, having lug at each end; pole clamping portion to be of length to leave one (1) inch space between lugs when assembled; each lug one and three-fourths (1¾) inches long with hole nine-sixteenths (9/16) inch diameter on center line with center three-fourths (¾) inch from end. (See Fig. 15.)

(*b*) To be furnished with two (2) bolts each one-half (½) inch diameter, two (2) inches long under head, and fitted with one (1) nut.

POLE STEPS:

29. (*a*) Pole steps for wood poles may have either button or spike heads unless particular kind is specified. Shank must be nine and three-eighths (9⅜) inches long under head, five-eighths (⅝) inch diameter, with thread three (3) inches long if twist, or two and five-eighths (2⅝) inches if fetter. (See Fig. 15.)

(*b*) Spike head must be one and one-half (1½) inches long on outside turned at right angles to shank, and of substantially the same cross section.

(*c*) Button heads must be one and one-half (1½) inches diameter and one-fourth (¼) inch thick, with rounded edge.

II Malleable Castings

CHARACTER:

30. All malleable fittings must be true to pattern, free from blemishes, scale or shrinkage cracks, and must comply with the current specifications of the American Society for Testing Materials for "Malleable Castings."

BRACKET FITTINGS, GENERAL:

31. Bracket fittings must have dimensions as follows:

Item	Light service 1½-in. tube or pipe	Heavy service 2-in. tube or pipe
Inside diameter collar or socket	2 in.	2 7/16 in.
Distance axis of tube to center of strand eye	6⅜ in.	7 in.

BRACKET POLE CASTINGS FOR WOOD POLE:

32. Bracket pole castings for use on wood pole must consist of socket with two (2) lugs square with it, and may be from five and one-half (5½) to six and one-half (6½) inches long over lugs; each lug at least three-eighths (⅜) inch thick with hole nine-sixteenths (9/16) inch diameter having three-eighths (⅜) inch metal outside; socket one and five-eighths (1⅝) inches deep to an inside ledge at least one-eighth (⅛) inch wide by one-fourth (¼) inch thick; and average wall thickness not less than five-sixteenths (5/16) inch. (See Fig. 16.)

BRACKET POLE CASTINGS FOR STEEL POLE:

33. For use on steel pole socket must be cast on one of paired clamping bands three and one-half (3½) inches wide, not less than one-fourth (¼) inch thick having reinforcing ribs on edges. Socket must have axis radial to clamping surface, depth inside not less than one and five-eighths (1⅝) inches, and average wall thickness not less than five-sixteenths (5/16) inch. Portion clasping pole must be same inside diameter as section on which used; of length to leave one-half (½) inch space between parts when assembled; and secured by bolts, through lugs three-eighths (⅜) inch thick and of width to leave at least three-eighths (⅜) inch of metal outside nine-sixteenths (9/16) inch diameter bolt holes, or through device of equivalent strength. Each must be furnished with two (2) machine bolts, each one-half (½) inch diameter and two (2) inches long under head, with nut. (See Fig. 16.)

BRACKET INTERMEDIATE CASTINGS:

34. Intermediate castings must be split collar type with gap of at least one-fourth (¼) inch when installed; clamping lugs each one and one-half (1½) inches long, five-sixteenths (5/16) inch thick and one (1) inch wide with hole seven-sixteenths (7/16) inch diameter, center on center line and one-half (½) inch from end; collar one (1) inch wide by five-sixteenths (5/16) inch thick; leg in section a cross tapered from collar to eye with one web parallel to axis of collar and one-eighth (⅛) inch thick, other web one-fourth (¼) inch thick, eye one-half (½) inch inside diameter, axis parallel to collar axis, with rounded wall one-half (½) inch wide parallel to axis by five-sixteenths (5/16) inch thick. Casting must be furnished with machine bolt three-eighths (⅜) inch diameter and one and three-fourths (1¾) inches long, fitted with nut. (See Fig. 16.)

BRACKET OUTER END CASTINGS:

35. Outer end castings must have, for over support rod, a collar at least one (1) inch long with walls not less than one-eighth (⅛) inch thick and hole at least five-eighths (⅝) inch diameter inclined upward towards pole on pitch of one to four (1:4); tube socket with inside depth one and three-quarters (1¾) inches with walls not less than one-eighth (⅛) inch thick; leg T or I section, eye one-half (½) inch inside diameter, with axis at right angles to socket axis and with rounded wall one-half (½) inch wide parallel to axis, by five-sixteenths (5/16) inch thick. (See Fig. 16.)

EARS, MECHANICAL:

36. (*a*) Mechanical ears must have cross section which will permit internal stiffening ribs but will offer no obstruction to passage of trolley wheel. Boss must have face not less than one and three-eighths (1⅜) inch diameter, hole not less than seven-eighths (⅞) inch deep slightly counterbored and tapped to take five-eighths (⅝) inch diameter stud, and containing at least seven (7) full threads. Clip portion must be not less than one-sixteenth (1/16) inch thick at any point, and must be so reinforced that when installed it cannot be buckled sufficiently to affect its grip; top, at distance of one and three-fourths (1¾) inches from center of boss, must be at least seven-sixteenths (7/16) inch below plane of top of boss. (See Fig. 17.)

(*b*) Mechanical ears must be furnished with full complement of flat head iron machine screws, each eighteen (18) gauge, and of length to project one-sixteenth (1/16) inch beyond face of clip when installed. Screw slot must be one-sixteenth (1/16) inch wide and deep; screw holes in face of clip three-eighths (⅜) inch diameter and countersunk to take screw head; holes in back slightly counterbored to take screw and having at least four (4) full threads.

(*c*) Single clip mechanical ears must be seven (7) inches long, with four (4) screws.

FEEDER INSULATOR PINS:

37. (*a*) Feeder insulator pins may be cored but must be eight (8) inches long over all, head of type to readily cement or screw with full bearing into insulator; body round or star section, four (4) inches long from top of head to bearing face of shoulder, shoulder at least one-and-three-quarter (1¾) inches diameter and one-fourth (¼) inch thick; arm section round one-and-one-half (1½) inches diameter at shoulder and one-and-seven-sixteenths (1 7/16) inches diameter at lower end. (See Fig. 17.)

(*b*) Pin must stand without fracture or crack, and without a deflection of more than one (1) inch at point of application, a test pull of seventeen hundred (1700) pounds at right angles to the pin axis, applied three-and-one quarter (3¼) inches above the shoulder by a wire looped around the pin.

(The common commercial insulator thread has diameter at small end of either one (1) inch or one and three-eighths (1⅜) inches; four (4) threads per inch; and taper changing diameter one-sixteenth (1/16) inch per inch of length. Thread has ridge of semicircular cross section one-sixteenth (1/16) inch radius and flat valley with corner fillets one-sixty-fourth (1/64) inch radius.)

FROGS AND UNINSULATED CROSSINGS:

38. Frogs and uninsulated crossings must be so arranged on top that both wires can be carried through without cutting. The clamping device must allow adjustment if desired; when closed must rigidly hold wires without injury to them; and the runs and gaps must be designed to reduce sparking to a minimum. All frogs must have four (4) pull-off rings, one (1) at each corner.

GUY CLAMPS:

39. (*a*) Guy clamps may have over all length between five (5) and six (6) inches, but must have width one-and-nine-sixteenths (1-9/16) inches, each half nine-sixteenths (9/16) inch thick with three (3) bolt holes nine-sixteenths (9/16) inch diameter, on center line, end holes with centers at least three-fourths (¾) inch from end, those in head side having at outer end a recess fifteen-sixteenths (15/16) inch square and one-eighth (⅛) inch deep to receive bolt head; each half having midway between bolt holes and edges wavy grooves which must register and securely hold guys of from one-fourth (¼) inch to three-eighths (⅜) inch diameter. (See Fig. 14.)

(*b*) Each clamp must be furnished with three (3) machine bolts each one-half (½) inch diameter, one-and-three-fourths (1¾) inches long under head, threaded at least one-and-one-eighth (1⅛) inches and fitted with nut.

UNINSULATED PULLOVER BODIES:

40 (*a*) Uninsulated pullover bodies, both single and double, preferably of I section, must have web or rib not less than three-sixteenths (3/16) inch thick, boss one-and-five-sixteenths (1-5/16) inches long face to face, tap bolt hole eleven-sixteenths (11/16) inch diameter; clevises with nine-sixteenths (9/16) inch opening with horizontal jaws each one-fourth (¼) inch thick and one-and-one-quarter (1¼) inches wide with hole one-half (½) inch diameter having at least three-eighths (⅜) inch metal outside and squarely opposite hole of other jaw; clear space behind bolt not less than five-eighths (⅝) inch. (See Fig. 17.)

(*b*) Distance, center of boss to center of cotter bolt must be between four-and-three-quarters (4¾) inches and six (6) inches; throat depth from plane of lower boss face to center line of jaws must be not less than one-and-one-quarter (1¼) inches for at least two (2) inches either side of center.

(*c*) Bodies must be furnished with one (1) tap bolt and one (1) lock washer, also one (1) cotter bolt for each jaw.

III. Commercial Steel and Iron

BRACKET ARMS:

41. (*a*) Bracket arms may be tubing or pipe.

(*b*) For light service tubing or pipe must be one-and-nine-tenths (1.9) inches external diameter with walls one-hundred-and-forty-five-one-thousandths (0.145) inch thick, weighing two-and-sixty-eight-one-hundredths (2.68) pounds per foot.

(*c*) For heavy service tubing or pipe must be two-and-three-hundred-and-seventy-five-one-thousandths (2.375) inches external diameter, with walls one-hundred-and-fifty-four-one-thousandths (0.154) inch thick weighing three-and-six-tenths (3.6) pounds per foot. (See Fig. 18.)

GUY PLATES:

42. Guy plates must be number fourteen (No. 14) U. S. gauge sheet steel, four (4) inches wide by eight (8) inches long, bent lengthways to radius of five (5) inches with hole three-sixteenths (3/16) inch diameter in each corner one-half (½) inch from adjacent edges. (See Fig. 18.)

HUB GUARDS:

43. Hub guards must be one-eighth (⅛) inch thick plate eighteen (18) inches long by sixteen (16) inches wide, bent crosswise to radius of seven-and-one-half (7½) inches, each side with row of three (3) holes equidistant, nine-sixteenths (9/16) inch diameter, centers one (1) inch from side, corner hole centers one (1) inch from end. (See Fig. 18.)

THIMBLES:

44. Thimbles must be horse-shoe shaped with ends properly beveled for closing when installed. (See Fig. 18.)

Dimensions must be:

Item	For 1-in. guy rod	For other service
	(*Inches*)	(*Inches*)
Length over all	3⅜	3
Inside radius of top	15/16	⅝
Groove radius	⅜	¼
Groove depth	7/32	¼
Thickness at bottom of groove	7/32	5/32
End opening	1⅛	¾

WASHERS:

45 (*a*) Washers, except for anchor rods, must be round of following dimensions: (See Fig. 18.)

For Rod or Bolt	Outside diameter	Diameter hole	Thickness United States Gauge
(*Inches*)	(*Inches*)	(*Inches*)	
⅜	1	7/16	No. 14
½	1⅜	9/16	No. 12
⅝	1¾	11/16	No. 10
¾	2	13/16	No. 9
⅞	2¼	15/16	No. 8
1	2½	1 1/16	No. 8

(*b*) For anchor rods washers must be square of following dimensions: (See Fig. 18.)

For Rod	Washer surface	Thickness	Diameter hole
(*Inches*)	(*Inches*)	(*Inches*)	(*Inches*)
⅝	3 x 3	3/16	1¼
¾	3 x 3	3/16	1¼
1	4 x 4	¼	1½

WOOD CROSS ARMS

MATERIAL REQUIREMENTS:

46. Cross arms may be of cypress, Douglas fir, Norway pine or yellow pine, but must be thoroughly seasoned, sound, and free from wane or defects which would reduce strength; the grain must be close and not out of parallel with any edge of arm more than one (1) inch in three (3) feet of length.

PITCH POCKETS:

47. Pitch pockets not exceeding two (2) inches in depth, up to twelve (12) inches in length or one-fourth (¼) inch in width, not entering pin or bolt holes on top or sides of arm, will be permitted provided the area does not exceed one-half (½) square inch if within one (1) foot of center bolt hole, nor exceed one (1) square inch if outside the one (1) foot limit. Pitch seams or streaks which do not open the grain are not considered "pockets".

SHAKES AND CHECKS:

48. Ring shakes, end checks, or other checks entering pin or bolt holes will not be permitted; a few fine checks not entering pin or bolt holes, nor exceeding six (6) inches in length nor one-half (½) inch in depth, will be allowed.

KNOTS:

49. No knots will be allowed within twenty-four (24) inches of center of any arm, nor entering any pin or bolt hole. Sound knots not exceeding three-fourths (¾) inch diameter, and not entering any pin or bolt hole will be allowed between limits twenty-four (24) inches and thirty-six (36) inches from center of any arm; outside limit thirty-six (36) inches from center of any arm, sound knots not entering a pin or bolt hole may increase in size to not exceed one (1) inch diameter at end of arm.

SAP WOOD:

50. Cypress arms must be free from sapwood or pitch heart; Douglas fir, Norway pine, and yellow pine arms may contain, on top or one

side only, clear sap wood of maximum cross section not exceeding fifteen (15) per cent of total cross section of arm.

WARP:

51. Cross arms must be out of wind; must not be bent edgeways in any direction, nor sideways in more than one (1) direction; and a straight edge applied to concave side must not show offset exceeding one-eighth (⅛) inch per foot of length of arm.

FINISH:

52. Arms must be delivered unpainted with every face planed, square to adjacent faces and bored as specified. Holes must be accurately located, square with face, clean cut, not badly splintered where bit passed out, and within one-thirty-second (1/32) inch of correct diameter.

BORING:

53 (*a*) All cross arms must have holes one-and-one-half (1½) inches diameter on center line of top, one (1) on either side of and with center fifteen (15) inches from arm center, others twelve (12) inches apart center to center on light service arms, and ten (10) inches on heavy service arms.

(*b*) All cross arms must have one (1) center hole eleven-sixteenths (11/16) inch diameter in center of side.

(*c*) All cross arms to be strap braced shall have two (2) holes each seven-sixteenths (7/16) inch diameter on center line of side, one (1) on either side of center hole; twelve (12) inches distant for two (2) pin arms and nineteen (19) inches distant for all others.

(*d*) All cross arms to be angle braced shall have two holes, each nine-sixteenths (9/16) inch diameter on center line of bottom, and spaced one (1) either side of middle, twenty-one (21) inches distant for four (4) pin and six (6) pin arms, and thirty (30) inches distant for eight (8) pin arms. (See Fig. 19.)

CLASSES AND SECTION:

54. Cross arms are of two (2) classes: Light service arms, three-and-one-quarter (3¼) inches wide by four-and-one-quarter (4¼) inches deep; and heavy service arms, three-and-three-quarters (3¾) inches wide by four-and-three-quarters (4¾) inches deep. (See Fig. 19.)

LENGTHS:

55. Cross arms lengths must be as follows: (See Fig. 19.)

Size of Arm	Light service	Heavy service
	(*Inches*)	(*Inches*)
2 pin	36	.....
4 pin	60	58
6 pin	84	78
8 pin	108	96

NOTE: Figs. 11 to 19 inclusive show overhead line material as described in the above specifications.

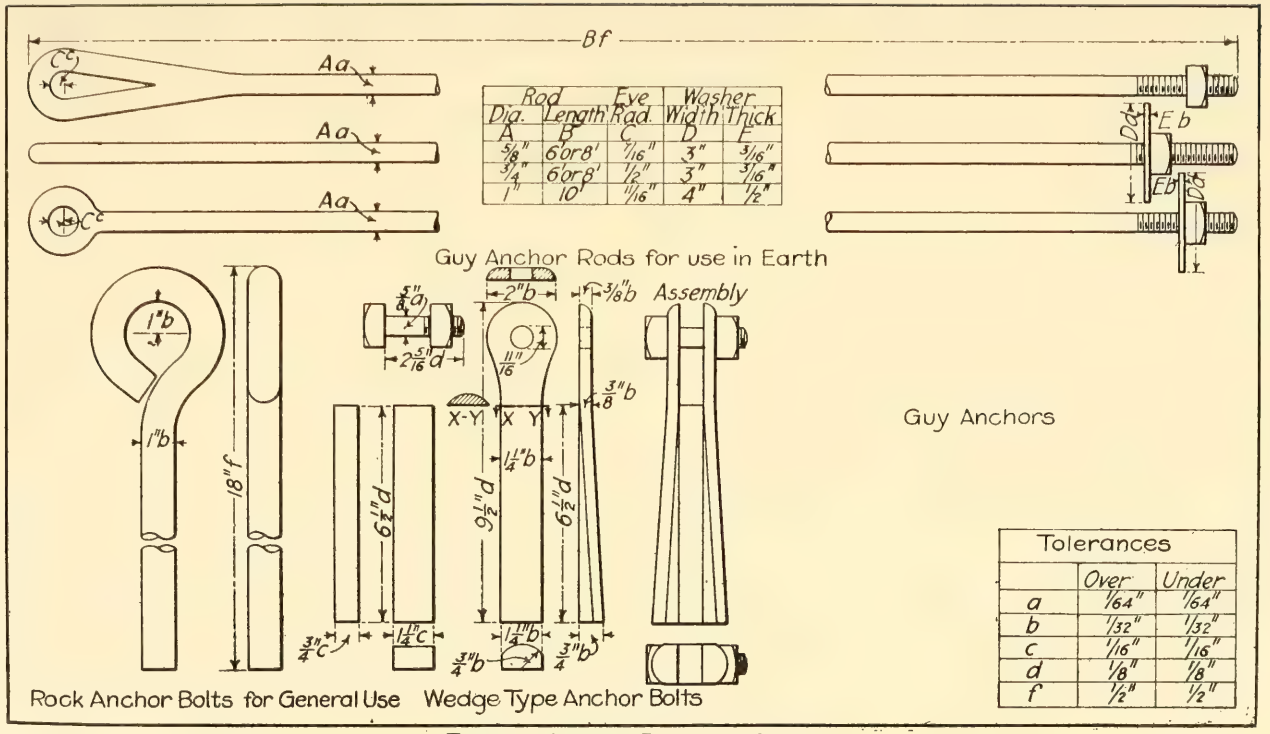


FIG. 11. ANCHOR RODS AND BOLTS.

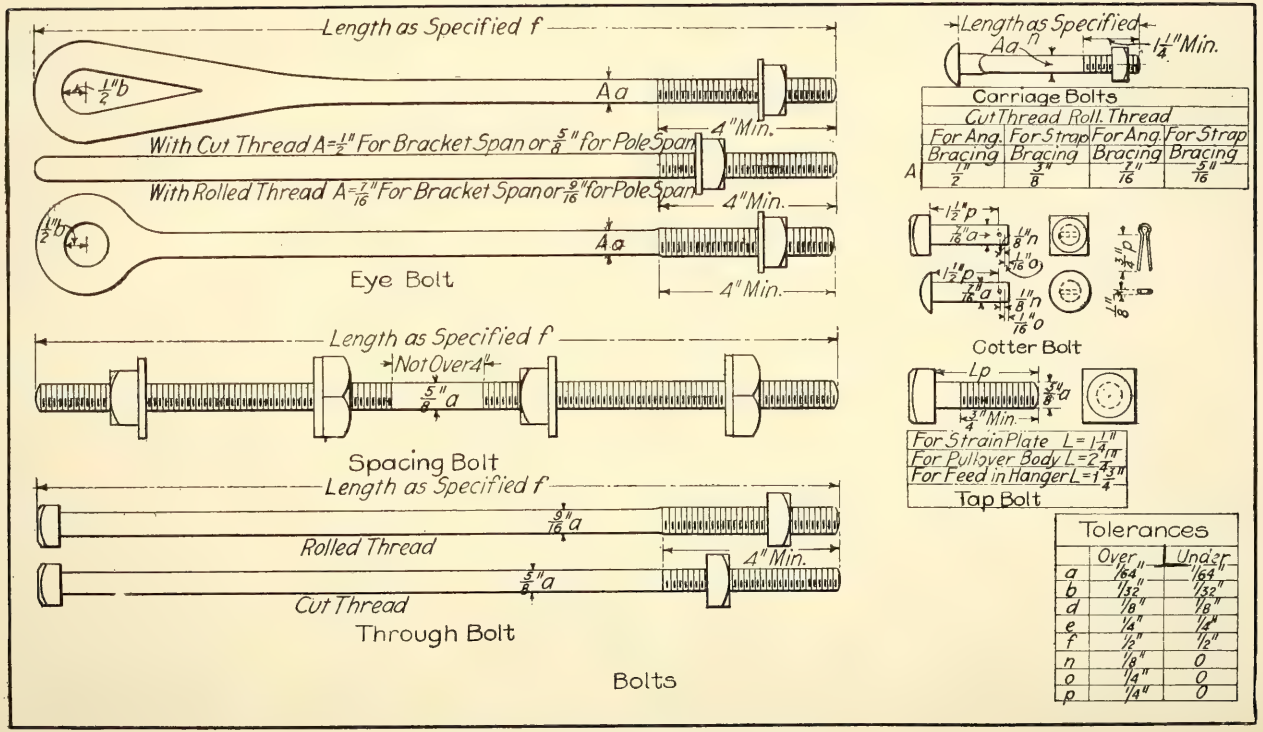


FIG. 12. BOLTS FOR OVERHEAD LINES.

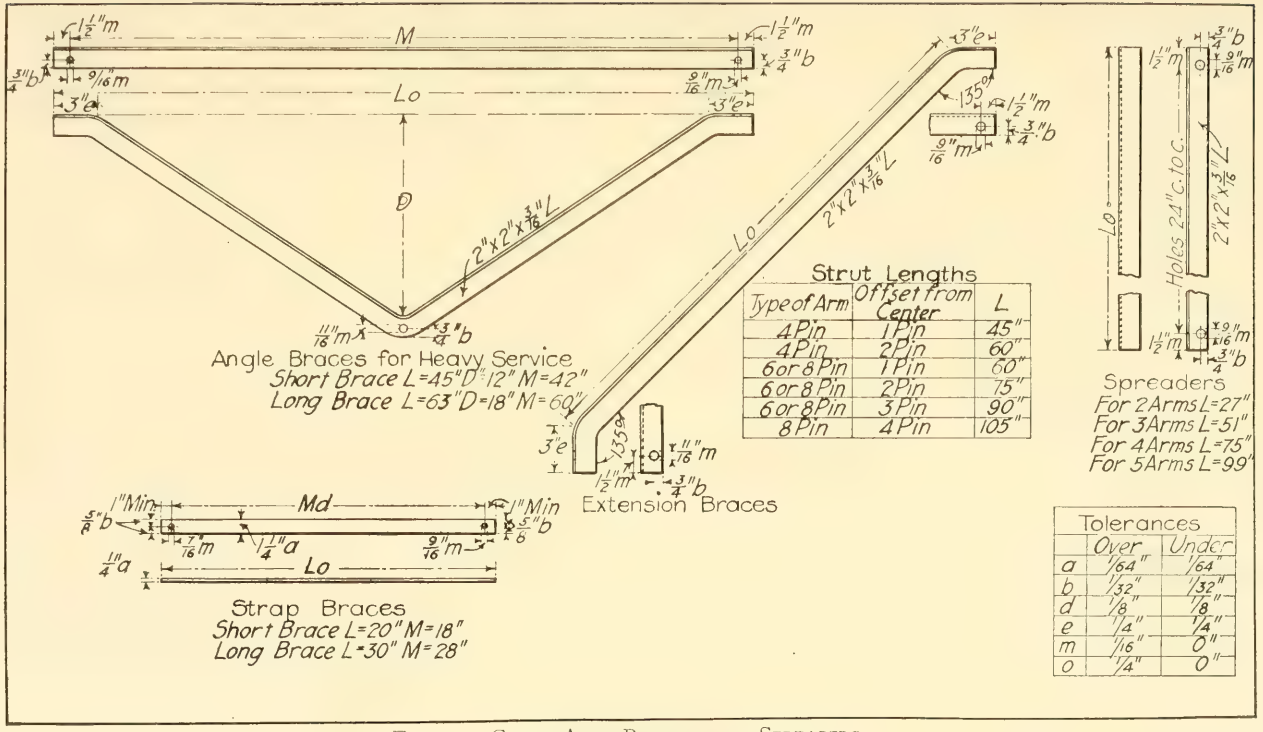

M
Lo
D
2"x2"x3/16"L
Angle Braces for Heavy Service
Short Brace L=45" D=12" M=42"
Long Brace L=63" D=18" M=60"
Md
Strap Braces
Short Brace L=20" M=18"
Long Brace L=30" M=28"
135°
Extension Braces
Strut Lengths
Type of Arm | Offset from Center | L
4 Pin | 1 Pin | 45"
4 Pin | 2 Pin | 60"
6 or 8 Pin | 1 Pin | 60"
6 or 8 Pin | 2 Pin | 75"
6 or 8 Pin | 3 Pin | 90"
8 Pin | 4 Pin | 105"
Holes 24" c. to c.
7 3/8"x2"x2"
Spreaders
For 2 Arms L=27"
For 3 Arms L=51"
For 4 Arms L=75"
For 5 Arms L=99"
Tolerances
| Over | Under
a | 1/64" | 1/64"
b | 1/32" | 1/32"
d | 1/8" | 1/8"
e | 1/4" | 1/4"
m | 1/16" | 0"
o | 1/4" | 0"

FIG. 13. CROSS ARM BRACES AND SPREADERS.

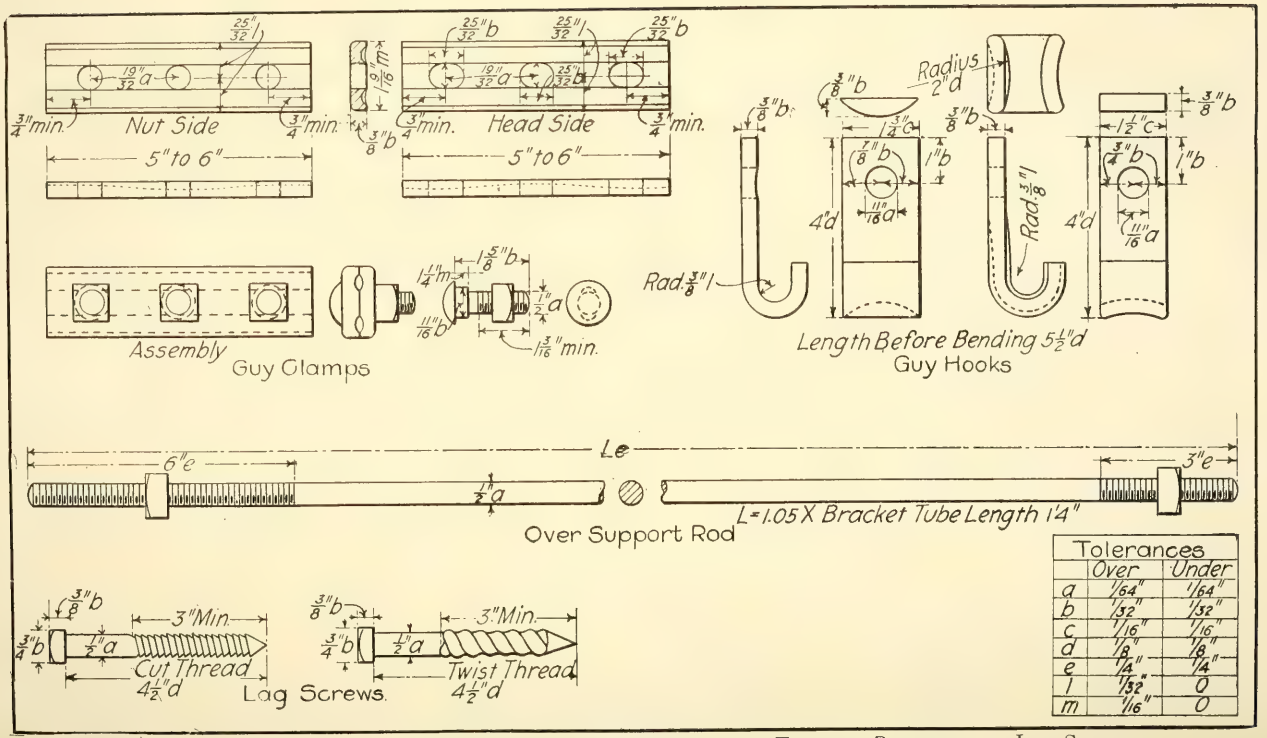


FIG. 14. GUY CLAMPS AND HOOKS, OVER SUPPORT ROD FOR TROLLEY BRACKET AND LAG SCREWS.

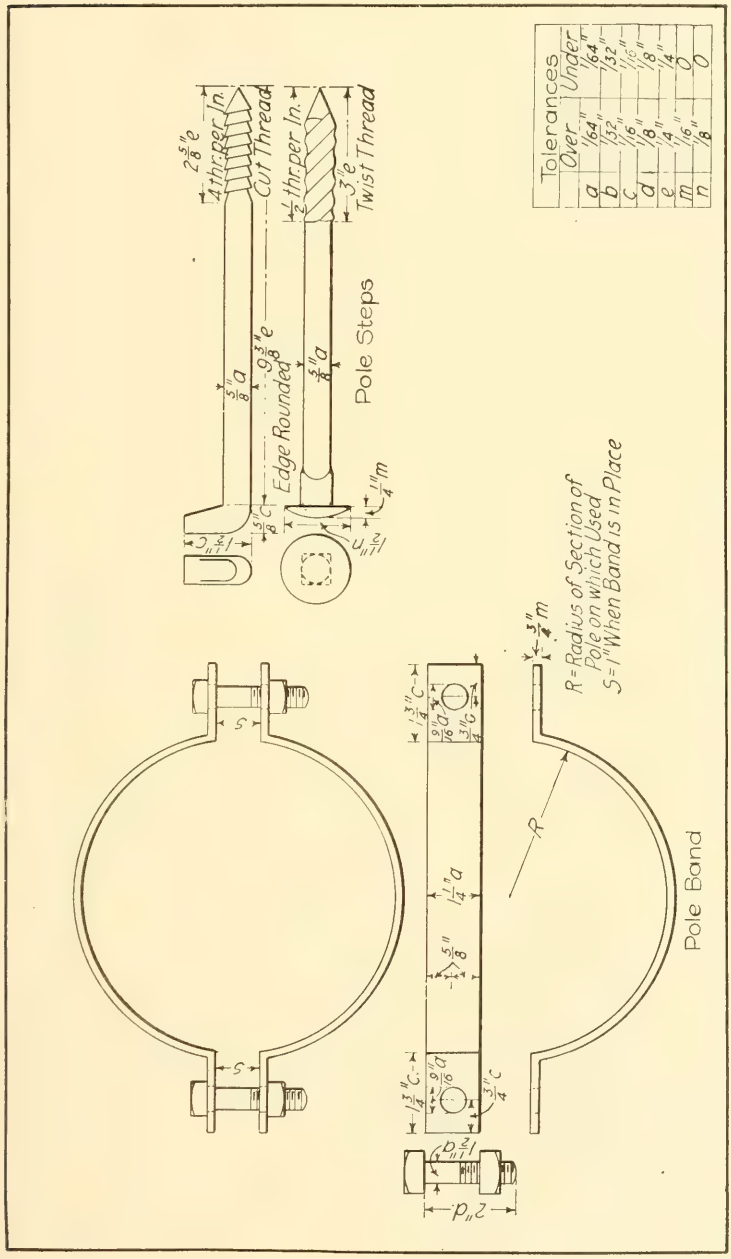
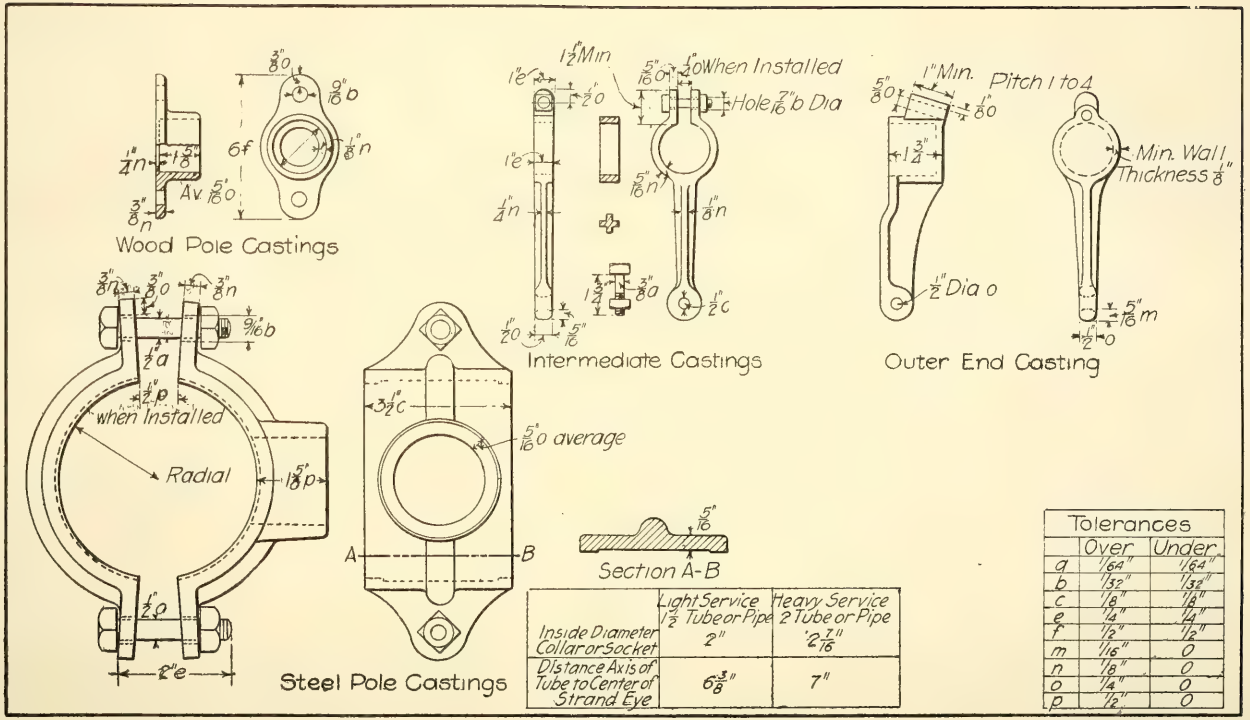


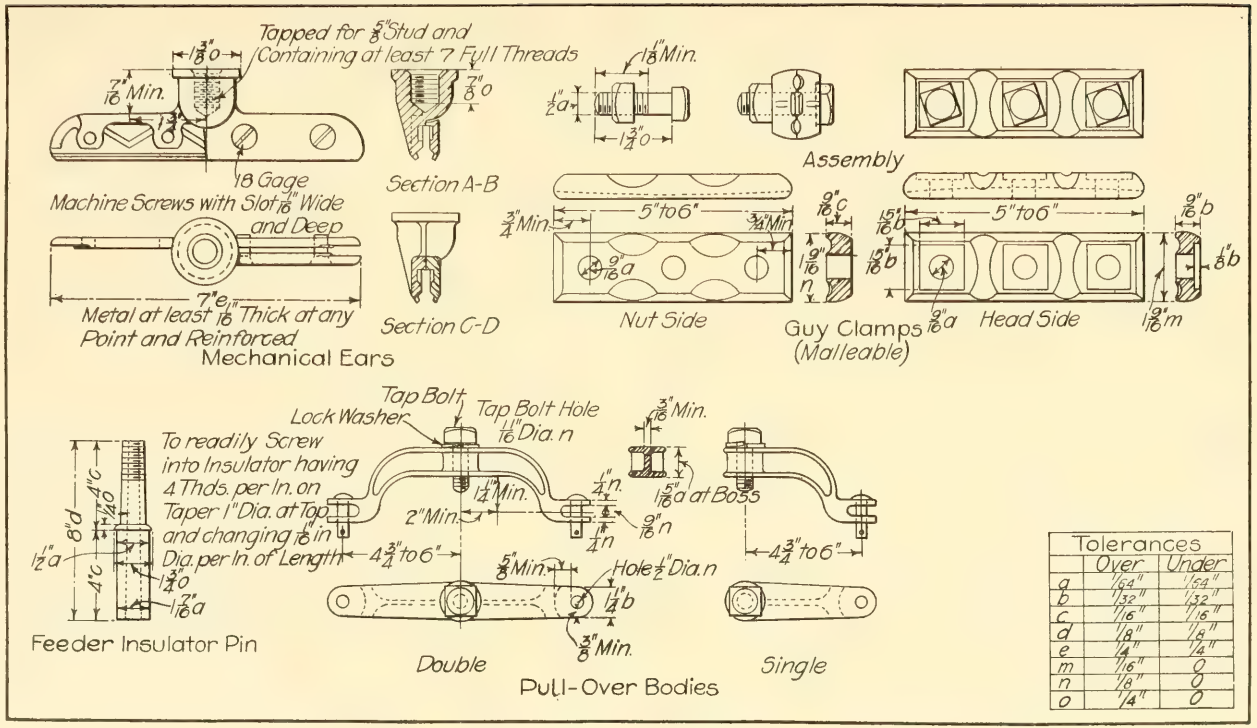
FIG. 15. POLE BANDS AND STEPS.



Inside Diameter Collar or Socket	Light Service 1 1/2 Tube or Pipe 2"	Heavy Service 2 Tube or Pipe 2 1/16"
Distance Axis of Tube to Center of Strand Eye	6 3/8"	7"

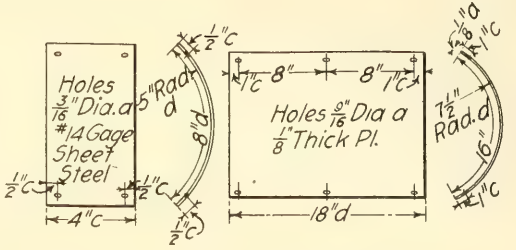
Tolerances	Over	Under
a	1/64"	1/64"
b	1/32"	1/32"
c	1/8"	1/8"
e	1/4"	1/4"
f	1/2"	1/2"
m	1/16"	0
n	1/8"	0
o	1/4"	0
p	1/2"	0

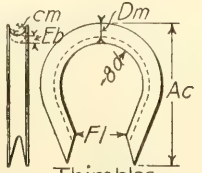
FIG. 16. TROLLEY BRACKET CASTING.


Tapped for 5/8" Stud and Containing at least 7 Full Threads
Machine Screws with Slot 1/16" Wide and Deep
18 Gage
Metal at least 1/16" Thick at any Point and Reinforced
Mechanical Ears
Section A-B
Section C-D
Assembly
Nut Side
Head Side
Guy Clamps (Malleable)
Tap Bolt
Lock Washer
Tap Bolt Hole 11/16" Dia. n
To readily Screw into Insulator having 4 Thds. per In. on Taper 1" Dia. at Top and changing 1/16" in Dia. per In. of Length
Feeder Insulator Pin
Double
Single
Pull-Over Bodies

Tolerances		
	Over	Under
a	1/64"	1/64"
b	1/32"	1/32"
c	1/16"	1/16"
d	1/8"	1/8"
e	1/4"	1/4"
m	1/16"	0
n	1/8"	0
o	1/4"	0

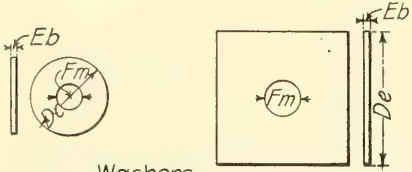
FIG. 17. GUY CLAMPS, TROLLEY EARS, PULL-OVER BODIES, FEEDER INSULATOR PIN.





Thimbles

	Fort Rod	Other Service
A	3 3/8"	3"
B	15/16"	5/8"
C	3/8"	1/4"
D	7/32"	1/4"
E	1/32"	5/32"
F	1 1/8"	3/4"



Washers

For Bolt or Rod	Outside Dia. or Side D		Thickness E		Dia. Hole F	
	Round	Sq.	U.S. Gage	Sq.	Round	Sq.
3/8"	1"	–	14"	–	7/16"	–
1/2"	1 3/8"	–	12"	–	9/16"	–
5/8"	1 3/4"	3"	10"	3/16"	11/16"	3/4"
3/4"	2"	3"	9"	3/16	13/16"	7/8"
7/8"	2 1/4"	–	8"	–	15/16"	–
1"	2 1/2"	4"	8"	1/2"	1 1/16"	1 1/8"

Tolerances		
	Over	Under
a	1/64"	1/64"
b	1/32"	1/32"
c	1/16"	1/16"
d	1/8"	1/8"
e	1/4"	1/4"
l	1/32"	0
m	1/16"	0

FIG. 18. TROLLEY BRACKET TUBE, GUY PLATE, HUB GUARD, THIMBLES AND WASHERS.

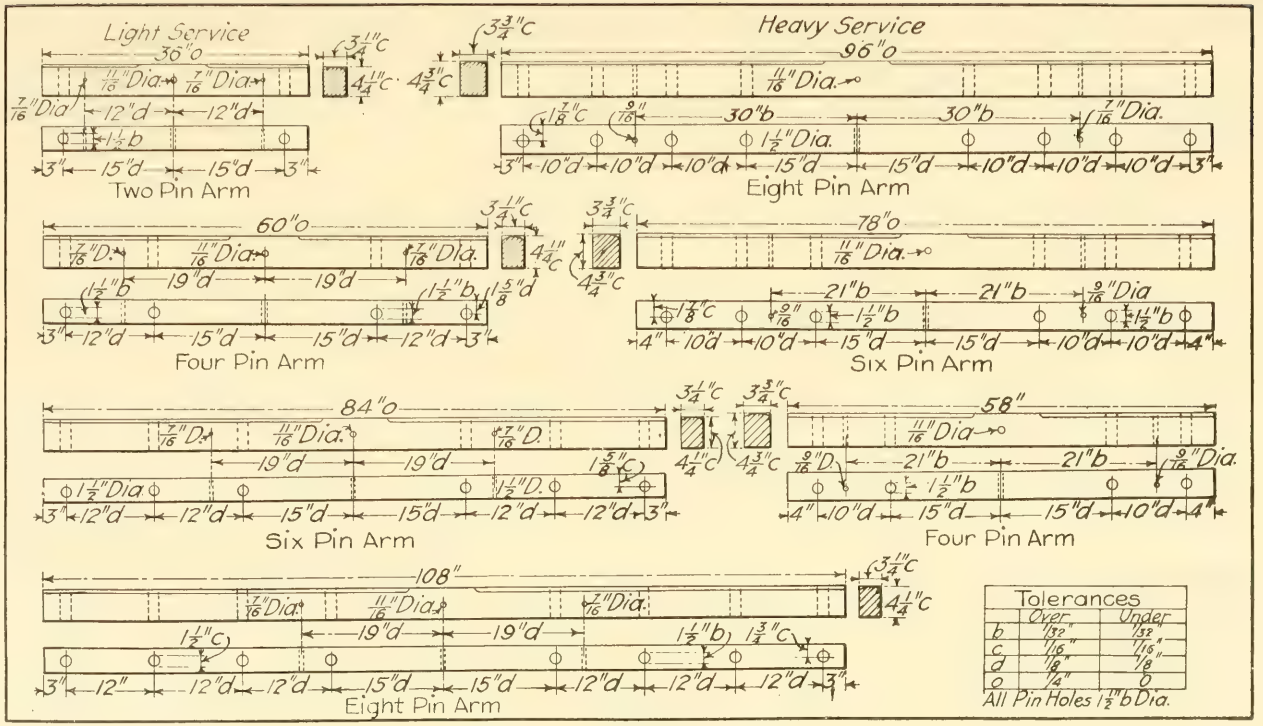


FIG. 19. WOOD CROSS ARMS.

LIGHTNING ARRESTER LOCATION AND GROUNDS*

Some objections having been raised to Sections 81 and 82 of the Recommended Specifications for Overhead Trolley Construction, as adopted in 1913 (1913 Proceedings, page 123), the 1914 Committee proposed new wording for these sections (1914 Proceedings, page 37). This wording was not satisfactory to the Association and these two sections were referred back to the Committee at the 1914 Convention (1914 Proceedings, page 101). The two sections, as they stand at present, will be found in the 1913 Proceedings page 123, and in the Engineering Manual, Section Ds 2a, page 20. During the present year the Association has appointed a Special Committee on Lightning Protection, as previously noted in this report. The following changes are recommended by the Committee on Power Distribution in order to meet the objections which have been raised and to conform with the ideas of the Special Committee on Lightning Protection, as understood by your Committee at this time. (July 15.)

NOTE: In the following, the words enclosed in brackets are recommended to be stricken out of the present specifications and the words printed in italics are recommended to be added.

LIGHTNING ARRESTERS — LOCATION:

81. Lightning arresters where required by local conditions shall be installed at feed taps, just below the feeder cross-arm and shall be connected to the feed tap close to its attachment to the feeder by solid insulated number four (No. 4) copper wire.

[The ground wire shall be of solid insulated number four (No. 4) copper wire, stapled to back of pole, and either extended as a ground coil or well soldered into a pipe ground. In either case the lower portion shall be protected by a wood moulding eight (8) feet long, with groove one-half (½) inch square in one (1) side, well painted all sides with paint or other preservatives and placed with lower end one (1) foot below the surface of the ground.]

The ground connection shall be of solid copper wire not less than number four (No. 4) securely fastened to the back of pole and (except as limited by Section 82) well bonded to the track rails and either (a) extended as a ground coil or (b) well soldered into a ground pipe. In any case, at least eight (8) feet of the lower exposed portion shall have a non-metallic protection. Any changes in the direction of ground wire must be made by easy curves.

LIGHTNING ARRESTERS — GROUNDS:

[82. Lightning arrester grounds shall not be attached to the track rails.]

82. (a) *Line lightning arrester ground wires shall be connected to a good earth ground and also to the track rail, except under the following conditions:*

* Amendments formally approved by both the Committee on Standards and the 1915 Convention.

(1) *Where the current flow (see note) on the connection from track to earth would exceed an average of one-quarter ampere during any twenty-four hour period.*

(2) *Where alternating current track circuit block signals of the double rail type are used.*

Note—In checking up this current flow, the algebraic sum of currents flowing first in one direction and then in the other, shall be used in determining the current flow. It is assumed that a resultant of more than one-quarter ampere average in either direction should be avoided.

(*b*) *Earth grounds shall be secured as follows:*

(1) Where permanently moist earth is assured at reasonable depth the ground may consist of a one-half (½) inch pipe driven at least three (3) feet into the moist earth.

(2) Where there is doubt as to the condition of the soil, excavate. If permanently moist earth is reached, install pipe ground; if otherwise, install a flat coil containing forty (40) lineal feet of solid number four (No. 4) bared copper wire bedded in not less than seven (7) cubic feet of charcoal.

(*c*) Particular care must be taken to ensure that the ground is effective; unless a good ground is secured the arrester cannot give protection.

REVISION OF EXISTING STANDARDS AND RECOMMENDATIONS

Your Committee has considered the existing Standards and Recommendations of the Association which originated with the Committee on Power Distribution and makes recommendations as follows:

Recommended Specification for 600 Volt Direct Current Overhead Trolley Construction*

This specification (1913 Proceedings, pages 105–139, Manual Ds 2a) was approved as a Recommended Specification by the 1913 Convention and by the Committee on Standards on January 30, 1914. Use of the specification has developed the necessity for certain modifications in addition to those relating to lightning arresters as recommended above, and the Committee herewith recommends that additional changes be made as follows:

Note: The words enclosed in brackets to be omitted and the words printed in italics to be added to the specification as it now exists.

HUB GUARDS:

23. Where hub guards are required, they shall be attached by lag screws on exposed face of pole at proper height.

(Sections 23–36, inclusive, to be advanced one number so that they will be numbered 24–37, inclusive.)

ANCHORS IN EARTH:

[29.] *30.* Anchors in earth shall consist of a wooden deadman *and guy rod, the deadman at least* four (4) feet long, [at least] *and* six

*Amendments formally approved by both the Committee on Standards and the 1915 Convention.

(6) inches thick, and having a cross section not less than forty-eight (48) square inches, buried at least four (4) feet below the surface with not less than two (2) feet of rock, if reasonably obtainable, well packed into hole, [and] the earth filling above thoroughly tamped, *the guy rod passing through the center and lying in the direction of the pull of the guy.*

[The anchor shall pass through center of deadman, and must lie in line of pull of guy, to prevent bending.]

Patent anchors of holding capacity equal to the breaking strain of the strand to be used with them, and having rugged parts sufficiently large to allow a reasonable amount of corrosion without reduction in holding capacity, may be used in place of rod and deadman where conditions are favorable.

ANCHORS IN ROCK:

[30.] *31.* Anchors in rock shall consist of eye-bolt securely leaded or sulphured for entire length of shank in hole *one-eighth* (⅛) *inch larger in diameter than bolt, and* inclined at right angles to pull of guy.

In rock of sufficient strength to safely withstand the action, mechanical wedge type eye-bolts may be used, and the lead or sulphur omitted. *Wedge bolt holes must lie in direction of pull of guy, and be of same size and shape as gripping body of assembled wedge bolt.*

GUY HOOKS:

[36.] *37.* Guy hooks attached one (1) on each side of pole at level of guy wrap by a throughbolt at right angles to line of pull shall be used where local conditions compel the use of a lead less than one-fourth (¼) distance from ground line at pole to guy wrap, *or where, as with guy plates, the guy must be held in particular position.*

GUY PLATES:

38. Guy plates, attached to pole by wire nails, shall be used behind guys the strain on which would otherwise cause material damage to wood poles.

(Sections 37–44, inclusive, to be advanced two numbers so that they will be numbered 39–46, inclusive.)

CROSS ARMS — STRAP BRACING:

[40.] *42.* Cross arms [three and one-quarter (3¼) inches wide by four and one-quarter (4¼) inches deep] *for light duty service* shall be steadied by strap braces secured to pole by a lag screw, and to side of arm away from pole by carriage bolts on center line of arm with nuts next to the braces *and a washer under bolt head.*

Arms [up to and including forty-eight (48)] *thirty-six* (*36*) inches in length shall have braces twenty [-four (24)] (*20*)inches long, fastened to arm [sixteen (16)] *twelve* (*12*) inches from center; arms over [forty-eight (48)] *thirty-six* (*36*) inches long shall have braces [twenty-eight (28)] *thirty* (*30*) inches long, fastened to arms nineteen (19) inches from center.

CROSS ARMS — ANGLE BRACING:

[41.] *43.* Cross arms [of section heavier than three and one-quarter (3¼) inches by four and one-quarter (4¼) inches] *for heavy duty service* shall be steadied by an angle brace, fastened to bottom of arm by carriage bolt and to pole by a throughbolt.

DOUBLE ARMS — INSTALLATION:

[44.] *46.* Double arms must be parallel and at the same height. Both arms shall be fastened to the pole by [the same throughbolt] *a spacing bolt with outside nuts only,* and shall be firmly tied together by spacing bolts with nut and washer each side of each arm, located on the center line of arm, eight (8) inches from end.

EXTENSION ARMS:

47. Where local conditions require, arms shall be offset from center as required, held to pole by throughbolt, and spread by a strut fastened to bottom of arm by carriage bolt and to pole by throughbolt. If there are two or more arms, they shall be further steadied by a spreader fastened by carriage bolts to side of arms midway between end pin and next pin; for very heavy service a spreader shall be used on each side.

(Sections 45–84, inclusive, to be advanced three numbers so that they will be numbered 48–87, inclusive.)

HEIGHT OF TROLLEY:

[46.] *49.* Supporting structures shall be of such height that *the lowest point of* the trolley wire in streets and on interurban lines shall be at a height of eighteen (18) feet above the top of rail *under conditions of maximum sag* unless local conditions prevent; on trackage operating electric and steam road equipment and at crossings over steam roads the trolley wire shall be not less than twenty-one (21) feet above the top of rail, *under conditions of maximum sag.*

TROLLEY WIRE — SPLICES:

[56.] *59.* Splices shall be of a type *and so installed as* to develop full strength of trolley wire, and [shall be so installed as] to offer the least possible obstruction to passage of trolley wheel. [Grooved wire must be kept in perfect alignment and] If splice is of soldering type, it shall be thoroughly sweated on without annealing the wire.

[In any case, the free ends of the wire shall be bent sharply back at outlet, and cut off forming a hook with end one-half (½) inch long.]

FEED TAPS — GENERAL:

[65.] *68.* Feed taps shall be at points of support and shall consist of proper size triple braid, weatherproof stranded *copper* connection [from feeder], *soldered to copper, or properly clamped to aluminum feeder.* Feed yoke *shall be* well soldered on at a proper point, and straight line ear soldered to the trolley wire and tap bolted to yoke. In general, feed taps will be located every one thousand (1,000) feet.

BRACKET FEED TAP:

[66.] *69.* With bracket support the feeder connection shall run from feeder [in which it shall be well soldered] to strain attached to span eye-bolt in pole, thence, replacing the usual steel strand, through insulated intermediate casting to strain attached to end casting of bracket. Bracket tube must be of sufficient length to allow at least eight (8) inches of connection cable between feed yoke and end strain, and intermediate casting should be so located that feed yoke is midway between it and end casting.

FEEDER STRINGING:

[68.] *71.* Feeder reel shall be mounted on an arbor on which it can freely turn, and if practicable, run along the line on a car or wagon. Where local conditions necessitate pulling feeder on and over the cross arms, great care must be taken to prevent injury, especially to [covered] *bare aluminum or any insulated* feeder, rollers or snatch blocks of ample size being used at each arm.

Table of Contents and Index to be revised in accordance with above. Figs. 1, 2, 4, 5, 6 and 10 to be revised in accordance with drawings submitted herewith (Figs. 20 to 25 inc.).

Pole Length	Depth of Hole in Rock or Concrete	Depth of Hole in Earth
30 Feet	5 Feet 0 Inches	6 Feet 0 Inches
35 "	5 " 6 "	6 " 0 "
40 "	5 " 6 "	6 " 6 "
45 "	6 " 0 "	6 " 6 "
50 "	6 " 6 "	7 " 0 "
55 "	6 " 6 "	7 " 6 "
60 "	7 " 0 "	8 " 0 "
65 "	7 " 0 "	8 " 6 "
70 "	7 " 0 "	9 " 0 "

Pole Setting

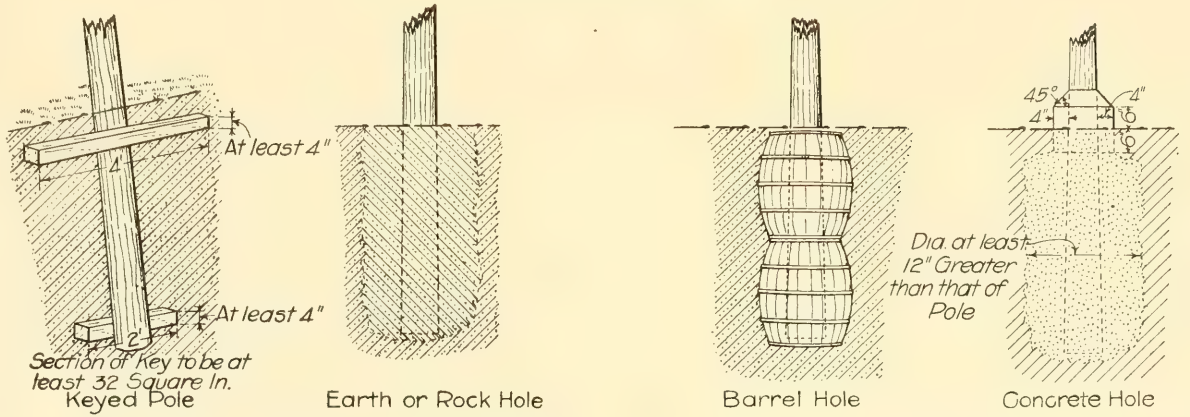


FIG. 20. (CORRECTING FIG. 1, ENGINEERING MANUAL DS 2A) METHOD OF SETTING POLES.

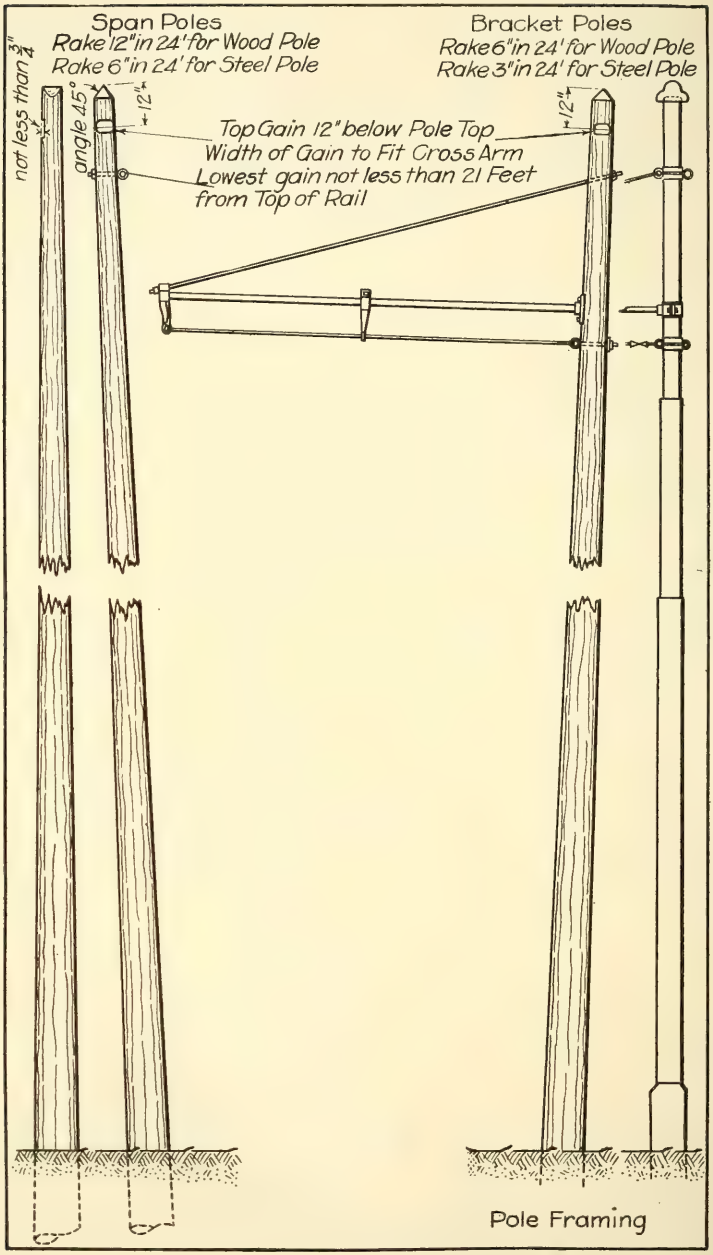

Span Poles
Rake 12" in 24' for Wood Pole
Rake 6" in 24' for Steel Pole
Bracket Poles
Rake 6" in 24' for Wood Pole
Rake 3" in 24' for Steel Pole
not less than 3/4"
angle 45°
12"
12"
Top Gain 12" below Pole Top
Width of Gain to Fit Cross Arm
Lowest gain not less than 21 Feet
from Top of Rail
Pole Framing

FIG. 21. (CORRECTING FIG. 2, ENGINEERING MANUAL DS 2A) POLE FRAMING.

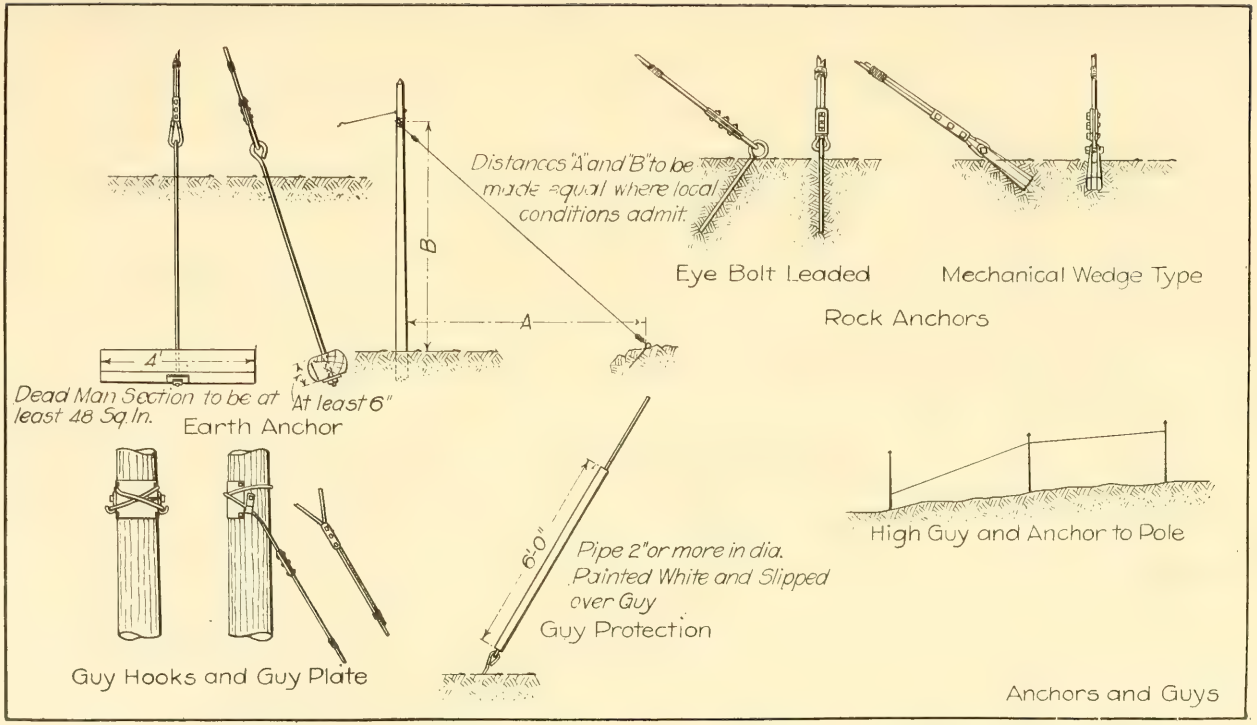

Distances "A" and "B" to be made equal where local conditions admit.
B
A
A
Dead Man Section to be at least 48 Sq. In.
At least 6"
Earth Anchor
Eye Bolt Leaded
Mechanical Wedge Type
Rock Anchors
High Guy and Anchor to Pole
6'-0"
Pipe 2" or more in dia. Painted White and Slipped over Guy
Guy Protection
Guy Hooks and Guy Plate
Anchors and Guys

FIG. 22. (CORRECTING FIG. 4, ENGINEERING MANUAL DS 2A) METHODS OF MAKING UP GUYS TO ANCHORS.

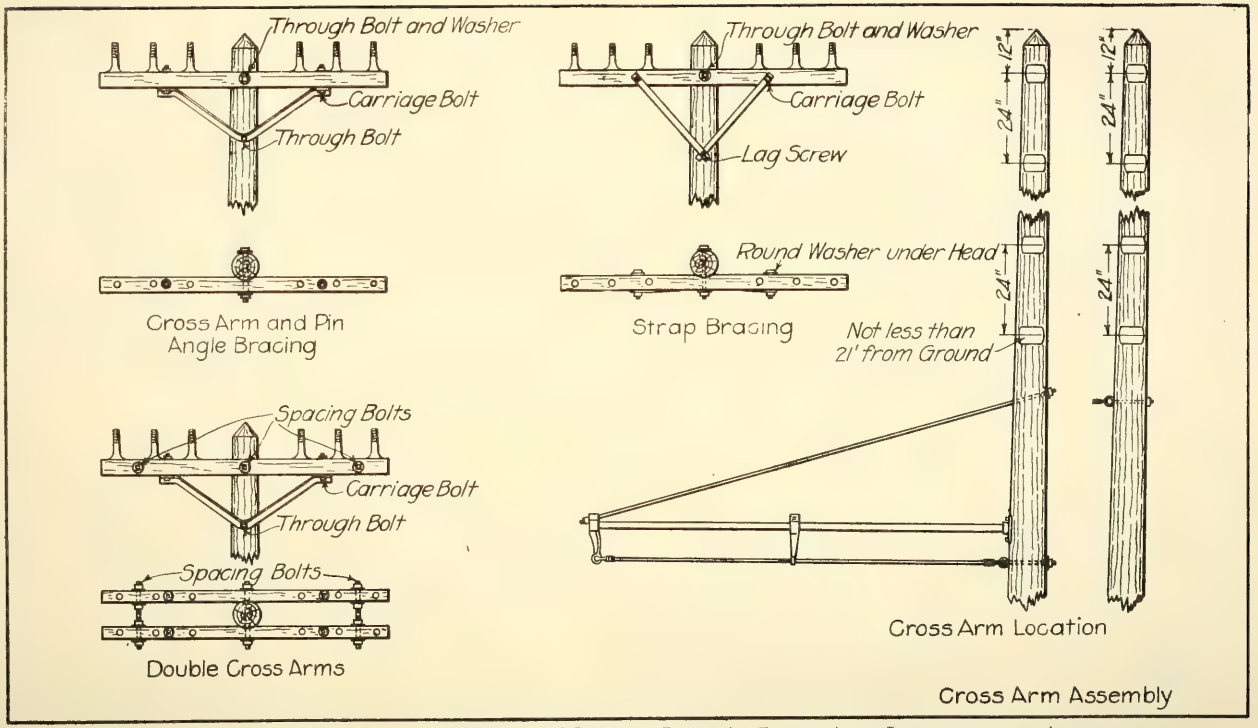


FIG. 23. (CORRECTING FIG. 5, ENGINEERING MANUAL DS 2A) CROSS ARM LOCATION AND ASSEMBLY.

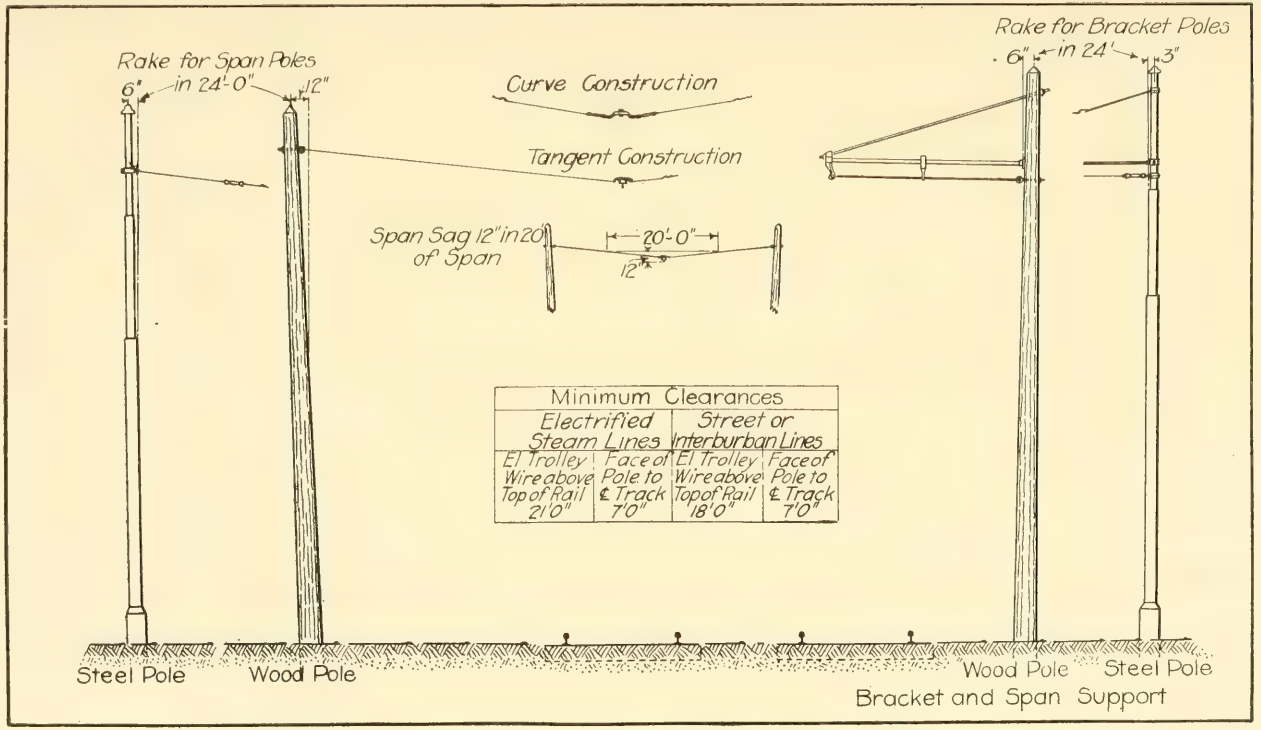


FIG. 24. (CORRECTING FIG. 4, ENGINEERING MANUAL, DS 2A) BRACKET AND SPAN TROLLEY SUPPORTS.

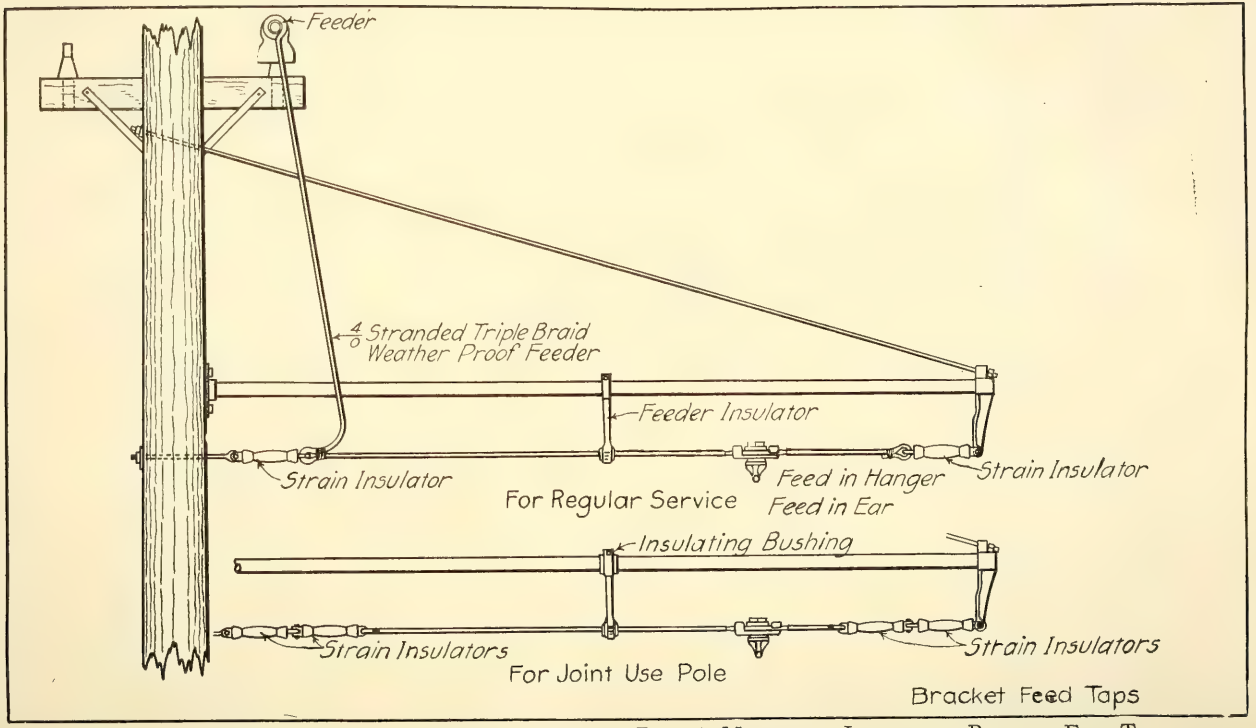


FIG. 25. (CORRECTING FIG. 10, ENGINEERING MANUAL DS 2A) METHOD OF INSTALLING BRACKET FEED TAPS.

RECOMMENDED SPECIFICATION FOR OVERHEAD CROSSINGS OF ELECTRIC LIGHT AND POWER LINES

This specification (1913 Proceedings, pages 140–148, Manual Ds 1b) was first approved by the 1911 Convention, disapproved by the 1911 Committee on Standards, revised and approved as Recommended Practice by the 1912 Convention and Committee on Standards, revised into its present form and approved as a Recommended Specification by the 1913 Convention and Committee on Standards (1913 Proceedings, pages 45, 151, 186).

The Committee on Power Distribution in 1913 called attention to the necessity of the formation of a National Joint Committee on Overhead Line Construction for the purpose of handling such matters as this one (1913 Proceedings, page 58), and the Executive Committee on October 13, 1913, recommended to the Executive Committee of the American Electric Railway Association that such a National Committee be formed to include representatives of the Committee on Power Distribution. On January 14, 1914 the American Association approved the plan for the formation of a National Joint Committee on Overhead Line Construction to be composed of representatives from the American Electric Railway Engineering Association, National Electric Light Association, American Institute of Electrical Engineers, and American Telephone & Telegraph Company, and that the scope of such committee should cover specifications for trolley contact wires over railway tracks, overhead crossings of electric light and power transmission lines, and construction of parallel lines in close proximity without incurring undue disturbances and dangers. After a considerable amount of correspondence, the *National Joint Committee on Overhead and Underground Line Construction* held its first meeting in New York on September 30, 1914, and perfected an organization. At the second meeting in New York on November 7, 1914, Mr. Farley Osgood was elected Chairman, Mr. George W. Palmer, Jr., Vice-Chairman, and Mr. R. D. Coombs, Secretary. The Committee now includes representatives from the American Electric Railway Association, American Electric Railway Engineering Association, American Institute of Electrical Engineers, National Electric Light Association, U. S. Bureau of Standards, American Railway Association, American Railway Engineering Association, Railway Signal Association, American Telephone and Telegraph Company, Independent Telephone Association, Western Union Telegraph Company, Postal Telegraph and Cable Company, Association of Railway Telegraph Superintendents, and the National Fire Protection Association. Eight meetings of the full committee have been held (to July 15) in addition to a number of sub-committee meetings. Among other subjects, this National Joint Committee is at present actively engaged in the revision of the Specification for Overhead Crossings of Electric Light and Power Lines.

When such revision by the National Joint Committee is completed, it will be submitted by the Committee on Power Distribution to the Association for its approval.

STANDARD STRANDING TABLE

The Standard Stranding Table of the Association was adopted by the 1912 Convention and Committee on Standards (1912 Proceedings, pages 378–395). The table is printed in the 1912 Proceedings, pages 144 and 145, and in the Manual, Dw 7a. This stranding is the same as is shown in the A. I. E. E. Standardization Rule No. 339, and your Committee has advice that the American Institute of Electrical Engineers proposes to change its present standard both by the addition of a stranding for bare cables for aerial use with a less number of strands than our present standard and by the addition of a standard stranding for flexible cables of a greater flexibility than our present standard. The Standards Committee of the American Institute of Electrical Engineers was informed that its proposed changes did not meet with the approval of the Committee on Power Distribution, and our latest advice (July 15) is that it would recommend the amended table for tentative adoption pending ratification by the American Electric Railway Engineering Association, American Society for Testing Materials and the National Electric Light Assocation. The President of the Engineering Association has appointed Mr. C. L. Cadle to represent the Committee on Power Distribution and Mr. W. W. Brown to represent the Committee on Equipment with the Sub-committee on Stranding of the Standards Committee of the American Institute of Electrical Engineers for any further consideration which it may give to the matter.

STANDARD SPECIFICATION FOR RUBBER INSULATED WIRE AND CABLE FOR POWER DISTRIBUTION PURPOSES

This specification (1914 Proceedings, pages 39–51) was adopted as a Standard Specification in 1914. In March 1915, your Committee received, through Mr. R. H. Rice, a communication from Mr. William A. Del Mar, Chairman of the Committee on Wire and Cable Specifications of the Association of Railway Electrical Engineers, a proposal to make certain modifications in this specification; namely, in Table VI of the specification (1914 Proceedings, page 47) to eliminate the words "shall not be greater than" from the heading of column 2, and the words "shall not be less than" from the heading of Column 4. Your Committee decided to recommend no action in this matter at the present time, and Chairman Del Mar was so notified.

It has also been proposed in connection with this same specification to change the required thickness of lead sheath, as specified in Section 22, page 49, 1914 Proceedings, so as to allow a sheath thinner than

⅛ inch for cable with less than 1750 mils diameter core. This proposal, however, was received too late for action by the present Committee, but should be considered by a succeeding committee.

STANDARDIZATION RULES OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Certain of the Standardization Rules of the American Institute of Electrical Engineers were assigned to your Committee for consideration. The rules so assigned were Nos. 321–366, 379–381, 388, 389, 404–414, all inclusive, as printed in the edition of December 1, 1914. After a careful consideration of the above mentioned Rules, and others, your Committee wishes to make but one suggestion, namely, as to the desirability of pointing out a definite dividing line between the transmission system, substation and distribution system, as defined by Rules 388, 389 and 390. It wishes to point out for the consideration of the American Institute of Electrical Engineers that this is especially desirable in view of the difficulty which is being experienced in conforming to the Classification of Accounts for Electric Railways as prescribed by the Interstate Commerce Commission, especially in determining the exact point where a transmission system ends and a distribution system begins at a substation.

Since your Committee has considered the above mentioned rules, there has been brought to its attention the fact that the A. I. E. E. has issued a revision of the December 1, 1914 edition, which bears the date of July 1, 1915.

CLEARANCE DIAGRAM FOR SEMAPHORE SIGNALS

The 1914 Committee on Block Signals submitted a clearance diagram for semaphore signals, as shown in the insert (Fig. 2) between pages 172 and 173, 1914 Proceedings. This diagram was referred back to the Committee on Block Signals by the 1914 Convention for further consideration jointly with the Committees on Heavy Electric Traction and Power Distribution. Your Chairman had some correspondence with Mr. G. N. Brown, Member of the Committee on Block Signals, both before and after April 30, 1915, at which time Mr. Brown met with the Committee on Power Distribution. As a result of this meeting and correspondence, it was agreed that the Committee on Block Signals would submit as a part of its 1915 report a revised clearance diagram with a dimension showing height of trolley bracket arm above rail as "minimum 20 ft. for brackets supported from poles on same side of track as semaphore signal when within 300 ft. of signal," and also showing dimension between center line of track and face of pole at the height of the semaphore signal as "minimum 7 ft. 7 in. Note: For poles carrying brackets on same side of track with semaphore signal when within 300 ft. of signal"; all other dimensions relative to overhead line construction to be omitted.

SPECIFICATIONS FOR JOINT USE OF WOOD POLES*

The report of the Committee on Joint Use of Poles as presented to the American Electric Railway Association in 1914 contained Specifications for Joint Use of Wood Poles (American Association Proceedings 1914, pages 82–91). The Committee report including these specifications was by action of the Convention (American Association Proceedings 1914, page 99) "received, filed and promulgated as a guide to member companies, but not to be understood as 'Standard.'" Your Committee believes that these specifications are of sufficient value that they should be made more accessible than at present to members of the Engineering Association, and therefore, in accordance with the action of the American Association that the report be "promulgated," recommends that that portion of the report of the Committee on Joint Use of Poles comprising the specifications and drawings be reprinted as a part of the Engineering Manual, together with the exact wording of the action of the American Association, as stated above.

SUBJECTS SUGGESTED FOR SUCCEEDING COMMITTEES

The following subjects are suggested for reference to succeeding committees: Further consideration of the subject of concrete poles including deflection formulæ and tables for tapered sections; Further specifications for overhead line material including especially a standard thread for pins and insulators (which subject should be taken up in connection with other Associations), and a specification for structural steel cross arms and fittings; Consideration of the matter of the use of aluminum cable, with specifications; Collection of data preparatory to possible standard specifications for high voltage direct current and catenary trolley construction.

Respectfully submitted,

EDW. J. BLAIR,
C. L. CADLE,
D. E. CROUSE,
CHARLES RUFUS HARTE,
RALPH H. RICE,
GAYLORD THOMPSON,
CARL F. WOODS,
GEORGE W. PALMER, JR., *Vice-Chairman,*
ALBERT S. RICHEY, *Chairman,*
Committee on Power Distribution.

*Formally approved by both the Committee on Standards and the 1915 Convention.

APPENDIX A

RESULTS OF TESTS OF CONCRETE POLES AT EAST MAIN STREET YARDS, ROCHESTER, N. Y., MARCH 27TH. 1915, TO DETERMINE THE DEFLECTION AT VARIOUS LOADS

Pole No. 1

28 ft. concrete pole 10 in. x 10 in. butt, 8 in. x 8 in. top.
4 rods 1¼ ft. Round Steel.
Pole set 5 ft. in the ground.
Point of pull 20½ ft. from ground.
Pole made December 3, 1914.
Pole set March 6, 1915.
Pole set in concrete.

Zero	Deflection (*Inches*)	Loading (*Pounds*)	Remarks
9 *in.*			
10 1/16	1 1/16	400	
10 7/8	1 7/8	500	
12 1/4	3 1/4	800	
14 5/16	5 5/16	1100	Pole checked 12′ and 4′ 6″ from ground on tension side.
15 3/16	6 3/16	1300	
17	8	1500	
16 9/16	7 9/16	1400	Back set.
9 11/16	11/16	No load	Back set.
17 3/8	8 3/8	1500	After pole had been let back and another pull taken.
19 1/4	10 1/2	1800	
21 1/2	12 1/2	1900	
23	14	2100	
38	29	2000	

Max. pull 2325 lb. Pole broken at ground with 2325 lb. pull.

Fig. 2, p. 65, shows the cracks appearing in the tension side of the pole for an 1800 lb. pull.

Pole No. 2

27 ft. concrete New York State Railways pole made 1914.
Pole set in concrete March 6, 1915.
Pole set 5 ft. in ground.
Point of pull 20½ ft. from ground.

Zero	Deflection (*Inches*)	Loading (*Pounds*)	Remarks
9 *in.*			
11 1/16	2 1/16	550	Small check 4 ft. above ground on tension side.
11 1/8	2 1/8	600	

12 1/4	3 1/4	900	
13 1/2	4 1/2	1100	
14 1/2	5 1/2	1250	
15 1/2	6 1/2	1400	
17 1/4	8 1/4	1700	
19 1/2	10 1/2	2050	
20 3/8	11 3/8	2150	Cracks opening up 7 ft. above ground on tension side.
21 3/4	12 3/4	2300	
23 3/8	14 3/8	2500	
24 15/16	15 15/16	2700	
		3000	Failed 7 ft. above ground.

A photograph (Fig. 3, p. 66) is shown of this pole at failure.

Pole No. 3

33 ft. 12 in. x 12 in. butt; 10 in. x 10 in. top; 4–1½ in. round steel rods.

Pole set 6 ft. in ground.

Point of pull 25½ ft. from ground, 18 in. from top of pole.

Pole made Dec. 3, 1914.

Pole set March 8, 1915.

Pole set in concrete.

Zero 6 *in.*	Deflection (*Inches*)	Loading (*Pounds*)	Remarks
6 5/16	5/16	300	
6 15/16	15/16	500	Checks began on tension side.
7 13/16	1 13/16	750	
9	3	1050	
10 15/16	4 15/16	1600	
12 5/8	6 5/8	1850	
13 11/16	7 11/16	2100	
14 13/16	8 13/16	2300	
16 1/4	10 1/4	2500	
17 3/8	1 3/8	125	Back set.
17 1/8	11 1/8	2600	
19 11/16	13 11/16	2800	
24 1/2		2800	Failure.

At 1000 lb. load there was an indication that pole moved in ground about 1/16 in.

Compression side crushed and crack on tension side opened at 2800 lb. pull.

Pole No. 4

35 ft. 14 in. x 14 in. butt; 12 in. x 12 in. top; 4–1¾ in. round rods.

Pole set 5 ft. 6 in. in ground.

Point of pull 28 ft. from ground.

Pole made Dec. 1, 1914.

Pole set March 8, 1915.
Pole set in concrete.

Zero 4 *in.*	Deflection (*Inches*)	Loading (*Pounds*)	Remarks
4 1/4	1/4	350	
4 11/16	11/16	700	
5 1/16	1 1/16	1000	
5 15/16	1 15/16	1400	
6 13/16	2 13/16	1700	First fine cracks tension side.
7 3/4	3 3/4	2100	
9 1/4	5 1/4	2700	
10 1/8	6 1/8	3000	
10 13/16	6 13/16	3200	
12 1/4	8 1/4	3500	
13 15/16	9 15/16	3700	
		4000	Failure.

A photograph (Fig. 4, p. 66) is shown of this pole after failure. Note that break occurs at ground line because of uniform reinforcement.

APPENDIX B

METHOD OF MANUFACTURING CONCRETE POLES IN ROCHESTER

By C. L. Cadle, *Electrical Engineer,*
New York State Railways, Rochester, N. Y.

GENERAL:

The concrete pole yard is situated in a portion of a working gravel pit, this location being chosen on account of the gravel being particularly well adapted for concrete work and on account of the gravel pit being located on one of the lines where a large number of poles are used. It is necessary to haul other materials approximately four miles from the Company's steam railroad terminal. The pole yard occupies a space of approximately 50 ft. wide and 300 ft. deep. A small building was constructed for the housing of cement and tools, this building being located on one side of the yard, approximately in the middle. The water for making the mixture was secured by sinking a well 18 ft. deep and located adjacent to the mixing board. The forms consist of 3 30 ft. with 6 extra bottoms; 2 35 ft. with 2 extra bottoms, and 3 45 ft. with 6 extra bottoms, and are laid on concrete stringers to prevent the form from being warped. Running along the side of the yard the entire length is a spur track for convenience in handling material and the finished product. A three-ton gantry crane spans the pole yard and track is laid so it can be operated the entire length. All heavy materials are handled in this manner.

FORMS:

The drawings (Fig. 5 to 7, inserted between pages 68 and 69) show the type, size and kind of forms used. With each form there are two extra bottoms, this being desirable as the sides of the forms can be taken away from the pole after the pole has been poured approximately three to five hours, the sides being made interchangeable so that approximately two poles can be made each day with the same set of forms. Poles from 27 to 30 ft. are made in the 30 ft. forms by blocking off the required length at the top of the pole. Any length of pole between 30 and 35 feet can be made in the 35 foot form in the same manner and any pole between 40 and 45 feet can be made in the 45 foot form by blocking off the bottom of the form. This gives practically a continuous range in the heights of poles from 27 to 35 feet and from 40 to 45 feet, which covers the majority of the different heights used on this road.

MANUFACTURE:

In the manufacture of a pole the rods are first made up into a form before they are set into the pole form, the rods being laid on stringers for ease in handling. The bottom half is then placed in a semi-circular

rack having grooves for holding each individual rod in its proper position. Cast iron rings of the proper diameter ⅛ in. thick and ¾ in. wide and having recesses cut in the outside of the circle are provided for the purpose of holding the rods in their proper position. These rings are wired to the bottom rods, the top rods then being placed in their respective recesses, which holds the reinforcing in circular form. The separators are placed 5 ft. apart, the rods being held in the separators by wrapping two turns of No. 12 iron wire around the outside of the rods at each separator. The form is then handled by inserting a ½ in. forged ring with a proper handle and small lug on the bottom at intervals of 10 ft. or less. Three men pick up the reinforcing rods now made into the form and set them on to the bottom of the pole form. A small foot on the forged rings holds the rods the proper distance from the bottom of the pole form. The sides of the form are then placed in position and the rods further held in position by fastening the handle of the forged rings to the top of the pole form, the form now being ready to pour. The concrete is mixed very thin, by hand on a mixing board, and carried by means of a steel bucket to the form. The bucket has an opening in the bottom for allowing the concrete to pour out easily. The bottom end of the pole is poured first and, as fast as it fills, the forging rings supporting the rods are taken out allowing the reinforcing rods to be held in position by floating in the concrete. After the concrete has been poured, the top is leveled off and the pole allowed to set at least three hours, after which time the sides may be removed and used over again. Before the pole is rolled off the bottom, it is necessary for it to set at least three days. Great care must be used, however, in rolling the pole over so as not to break off the edges. The poles are then allowed to cure at least ten days before they are moved. They are then placed in piles, being handled by a steel beam strapped to a pole and raised by means of the crane. Poles require at least thirty days' curing before setting; however, it is much better to give them a longer time.

MIXTURE:

The concrete mixture used is one part cement, two parts sand and two parts gravel. The proportion of sand and gravel is not measured by volume but taken directly from the gravel pit, the average run being approximately one-half sand and one-half gravel. The gravel is run through a ¾ in. screen, which allows no stones larger than approximately ½ in. in diameter to be used. The mixture is made sufficiently wet so that it will run readily.

MANUFACTURING COST:

The pole yard above described has a capacity of six poles per day and is handled by one Foreman and five men. The laborers work ten hours per day at 18 cents per hour and the Foreman works ten hours per day at 27½ cents per hour. It requires two men approximately all

their time with the exception of the time when the poles are being poured to get the rods ready for the forms.

Poles made during the year 1914 were made with labor as noted above (these figures do not include any interest or depreciation on the pole forms or original cost of pole yard) as follows.

Height of Pole (Feet)	Cost of labor	Cost of material	Total cost
27	$2 08	$4 83	$6 91
30	2 68	5 76	8 44
35	3 17	6 54	9 71
40	4 40	8 35	12 75
45	4 82	9 23	14 05

11453

REPORT OF COMMITTEE ON STANDARDS CONCERNING CERTAIN RECOMMENDATIONS OF THE COMMITTEE ON POWER DISTRIBUTION

1914-1915

Recommendation of the Committee on Power Distribution:

(*a*) As STANDARD: Specification for Tubular Steel Poles as shown on page 70 of this report. Amended Sections 8, 9, 11 and 14 of Specification shown in Engineering Manual Section Ds 5a.

Action of Committee on Standards:

That the recommended changes in specification be adopted.

Recommendation of the Committee on Power Distribution:

(*b*) As RECOMMENDED SPECIFICATION: Specification for Overhead Line Material as shown on page 82 of this report. That it be adopted as a Recommended Specification.

Action of Committee on Standards:

Adoption as **Recommended Specification** approved.

Recommendation of the Committee on Power Distribution:

(*c*) As A RECOMMENDED SPECIFICATION. Specification for 600 Volt D. C. Overhead Trolley Construction as shown on page 105 of this report. Recommended for adoption new sections on Hub Guards, Guy Plates and Extension Arms, and amendments to following Sections 29, 30, 36, 40, 41, 44, 46, 56, 65, 66 and 68 to supersede those in present Specification. (Table of Contents and Index being revised accordingly.)

Action of Committee on Standards:

That the recommendations of the Committee as to amendments to the Recommended Specification on 600 Volt D. C. Overhead Trolley Construction be approved.

Recommendation of the Committee on Power Distribution:

(*d*) As A RECOMMENDED SPECIFICATION. Specification for 600 Volt D. C. Overhead Trolley Construction:—Lightning Arrester Location and Grounds as shown on page 104 of this report. Recommended for adoption amendments to Sections 81 and 82 in lieu of present sections.

Action of Committee on Standards:

That the Recommendations of the Committee on the proposed revisions of Sections 81 and 82 be approved and adopted to supersede present wording.

Recommendation of the Committee on Power Distribution:

(*e*) Specification for Reinforced Concrete Poles. That the investigation be continued and that the modified Specification as presented on page 68 of this report be used in place of that shown in the 1913 Proceedings, page 98.

Action of Committee on Standards:

That the Specification as submitted be incorporated in Section Ds 3a of the Engineering Manual.

Recommendation of the Committee on Power Distribution:

(*f*) Table for Deflection and Loads and Pipe Table for Tubular Steel Poles, pages 76 to 81 be submitted for table shown in Section Ds 3a of Engineering Manual, and be incorporated in Standard Specification for Tubular Steel Poles.

Action of Committee on Standards:

Approved recommendation of Committee.

Recommendation of the Committee on Power Distribution:

(*g*) Specification for Joint Use of Poles. That the Specification and drawings be printed in Engineering Manual together with the resolution of the American Association in approving this Specification.

Action of Committee on Standards:

Approved recommendation of Committee.

Recommendation of the Committee on Power Distribution:

(*h*) Standardization Rules of the A. I. E. E. 321–366; 379–381; 388–389; 404–414. Suggested that a definite division be outlined so as to determine where transmission system ends and distribution system begins.

Action of Committee on Standards:

Approved suggestion of standing committee and in view of the fact that these rules have been further revised by the A. I. E. E. since their consideration by the committees, the new issue bearing date of July 1, 1915, that this subject be given further consideration.

Clearance Diagram for Semaphore Signals:

See Report of Committee on Block Signals.

Respectfully submitted,

C. F. Bedwell,
W. G. Gove,
E. R. Hill,
A. S. Richey,
J. W. Welsh,
C. S. Kimball,
E. B. Katté,
W. H. Sawyer,
F. R. Phillips,
J. H. Hanna,
C. H. Clark,
Martin Schreiber, *Vice-Chairman,*
H. H. Adams, *Chairman,*
Committee on Standards.

Discussion of Report of Committee on Power Distribution

PRESIDENT CRECELIUS:— This report is now before you. Before discussing the report as a whole, it is desirable that we concentrate our attention directly upon the specific Recommendations of the committee, which have received action by the Committee on Standards. After disposing of these Recommendations we can then open up the discussion of the report as a whole. That is the plan which has been followed in the past and which has been found to be very satisfactory. The first definite recommendation of the Committee on Power Distribution appears on page 125 of the report under the head "Report of Committee on Standards concerning certain recommendations of the Committee on Power Distribution." The first recommendation is that the amendments to the Standard Specification for Tubular Steel Poles (Eng. Man. Ds 5a) as shown on pages 70 and 71 of this report be approved.

W. G. GOVE:— The Committee on Standards has recommended that the amendments to the Specification be adopted.

C. R. HARTE:— I move the adoption of the recommendation.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the Specification for Overhead Line Material as shown on pages 82–103 of this report be adopted as a Recommended Specification.

W. G. GOVE:— The Committee on Standards has recommended that this be adopted as a Recommended Specification.

C. R. HARTE:— I move that the recommendation be adopted.

S. L. FOSTER:— Mr. Chairman and gentlemen; I rise, not to criticise this work of the Committee, because I consider it very creditably done, but as it differs in many particulars from our local practice, I feel that a few remarks may be of interest. I have occasionally been requested by the Executive to give my views on committee reports, but several years ago when the original specifications were sent here I was not so requested, and I was really relieved, because I found quite a few places in which our local practice differed from that specified by the Association. I had also come to feel that my suggestions in the past were apparently not considered. Now with regard to this specification.

On page 84 relative to Anchor Rods we specify that anchor rods shall be upset at the lower end and threaded so as to have the full diameter of the rod at the base of the thread. We considered that the threaded portion of the rod being in the ground corroded rapidly, and the rod was very apt to fail at that point, and it was our judgment that it paid us to make it at least the full strength of the rod at this vulnerable and inaccessible point.

On page 85, with reference to Carriage Bolts, we use lag screws, and we find them entirely satisfactory.

On page 85, with reference to Eye Bolts, we use 1-in. radius for the eye, and find that the blacksmiths are much more successful in doing good work with that radius than with the ½-in. radius as recommended by the Committee. All of our bolts are ⅝-in., some are specified as ½-in. by the Committee. Our Tap Bolts are ¾-in.

On page 86, with reference to Through Bolts, the Committee advises ⅝-in.— we use ¾-in.

On page 87, with reference to Strap Braces, the Committee advises 1¼ by ¼, and we use 1½ by $\frac{3}{16}$. As to Guy Clamps on the same page, we have found that a good wrapped connection is as cheap, strong, and looks much better, than the guy clamp, and hence do not use any guy clamps.

On page 88, with reference to Pole Bands, we use a one-part band. The Committee recommends a pole band made of two parts. The Committee also recommends the pole band 1¼ in. wide by $\frac{3}{16}$ in. thick, and we use one 2 in. wide by ¼ in. thick. We naturally use but one bolt while they recommend two bolts.

On page 89, relating to Bracket Pole castings for wood poles, we use no pipe brackets at all. We use angle iron brackets which we find much more durable. When a wild trolley pole hits one of these angle iron brackets the pole is apt to be broken. Usually the bracket is the thing broken off if made of pipe.

On page 92, with reference to Thimbles, never having seen an anchor guy break off in the anchor eye in thirty years practice, we see no need for the use of thimbles.

On page 94, relating to Boring. Our local ordinances provide that the arm shall be bored 13 in. from the center of the pole, and the committee recommends 15 in. Instead of putting the d.c. 500 volt equipotential pins 12 in. apart as recommended we put them 6½ in. apart.

Under Classes and Section the dimensions of wood crossarms are given for light service as 3¼ in. by 4¼ in. and for heavy service 3¾ in. by 4¾ in. For light a.c. high tension work in this vicinity most of the power companies use a 5¾ in. by 5¾ in. crossarm on account of the crossarm fires from fog conditions. For our trolley feeder work we use a 3¾ in. by 5¾ in. arm.

I think it is well for me to bring these points up, because I feel quite sure that these specifications will not be adopted in their entirety here. We feel confident that our present local practice meets our situation better than if these specifications, where referred to, were to be adopted.

PRESIDENT CRECELIUS: We are very glad to hear from Mr. Foster, as one of the principal reasons for the Association having its convention in San Francisco was to hear and consider carefully the views of our western representatives. Is there any further discussion along this line? If not, I will ask Mr. Blair to answer Mr. Foster's questions.

E. J. BLAIR:—I was very much pleased to hear Mr. Foster's discussion, for as our President has said, that is just the sort of thing the Committee wants, and it is good for the Association as a whole to have such discussions. I was doubly pleased in that I know we have some one here who can answer Mr. Foster's questions, namely the gentleman who did most of the work on this particular part of the report, Mr. Harte, of The Connecticut Company.

C. R. HARTE:— Mr. President and gentlemen. Answering the comments first in a general way, let me remind you that two years ago your Committee on Power Distribution put forward, and you adopted as recommended, a Specification for 600 volt D. C. Overhead Trolley Construction. The materials here described are, as far as they go, those with which the construction then adopted is to be done.

It was recognized, both in the adopted specification and in the one now before you, that it would be unwise to prescribe rigidly fixed standards to apply everywhere alike.

There are undoubtedly a number of things in each specification that are not best for certain parts of the country. I think there can be no question about that. Certain climatic conditions demand heavier or otherwise different construction than elsewhere. We do not want to say to the man whose work is in a dry climate or where there are no serious corrosive influences, that he must use material designed to meet conditions which only exist elsewhere, or to the man who has to contend with such destructive influences, that he must use light material. It appeared to us to be better to specify for what might be termed the normal condition, and in line with that thought the Committee on Power Distribution recommended, and the Committee on Standards has approved, giving the material specification the same standing as the construction form, namely as " Recommendation " ; not as " Standard " which ties hand and foot, but as the form we want to follow as closely as we can, yet recognizing the fact that there are some of us who cannot wisely live up to it exactly.

As to some of the specific details of which Mr. Foster spoke. It has been the experience of the members of the committee that anchor failures do not occur in the rod itself. My own company used the ¾ in. rod as standard, choosing this size to allow for corrosion, but a careful investigation failed to show warrant in normal construction for anything heavier than ⅝ in. for the rod with cut thread, or $\frac{9}{16}$ in. with rolled thread, which as you doubtless all know, upsets the stock to a diameter $\frac{1}{16}$ in. greater over the thread than in the body.

In the matter of the crossarm attachment, there is difference in practice. There are companies which use lag screws, and there are others which use bolts. The committee considered the question carefully for one man had used lag screws and said, frankly, he did not believe he would see the day when he would use through bolts on crossarms but he voted for the specification as it stands because he felt the general trend was towards the through bolt.

The eye bolt with one inch radius eye is standard in telegraph and telephone service, and is largely used in trolley overhead, and it seemed advisable to "join the crowd." Except that it is apparently more largely used, however, the adopted size has no particular advantage over the other.

Tap bolts are used in both ¾ in. and ⅝ in. sizes, but the tendency is towards the ⅝-in. and the Committee did not see where the added ⅛ in. of diameter of the larger size warranted the extra weight and higher cost.

For normal construction the stress on the crossarm through bolt does not begin to reach the tensile strength of a ½-in. bolt, the important factor being corrosion. Your Committee felt that the ⅝-in. bolt provided amply for corrosion, and that, other things being equal, it was desirable to have it this, the diameter of practically all the other bolts. Of course there are cases where a larger bolt is required, but these are special.

The strap braces specified are at present standard for a great deal of trolley overhead as well as for the American Telegraph and Telephone Co., the Western Union, and the National Electric Light Association. Your Committee has had strongly in mind in regard to all the material, that if, from the engineering point of view we could accept the standards of the other users, we would all be gainers. Fewer types, mean less machinery and patterns and lower overhead charges on the part of the manufacturer, while the dealer can carry a larger stock of the kinds used, and thus fill orders much better with no increase in investment. Telegraph, telephone, and electric light companies are today in the main standardized on material common to all, and while we have not always followed the exact wording of the other specifications, so far as it seemed practicable we have joined with our fellow builders of overhead work.

The question of making up eyes is one over which there always has been much discussion, and two years ago, in considering the matter, the Committee at first was divided, and that most vigorously, but eventually we agreed upon the use of the three-bolt clamps here described. The one on page 87

is the rolled steel type, and the one on page 91, which at first glance seemed to Mr. Foster to be the same, is the malleable form, which on closer examination will be seen to differ somewhat from the other. Both are stock commercial types, in very general use.

The question of the one-part or two-part pole band came up in the Committee, and it was the opinion that it was better to have the band of two parts than one part, since you do not have to strip the pole or bend the band all out of shape to get it off, and that advantage, to our minds, more than offset the disadvantage of the extra part. That is the whole question, whether it is better to have the nuisance of several parts, with greater ease of putting on and taking off, or whether we prefer the advantage of fewer parts with the resulting disadvantage of installation. In this case we felt the ease of installation was best.

The use or non-use of thimbles on strand eyes is a question of individual practice again; some use them and some do not. The Committee felt it was better general practice to use them.

The standard crossarm design starts fundamentally with the Specification for Joint Use of Poles, which was presented at the 1914 Convention, and which will appear hereafter in the *Engineering Manual.* The specification, as you remember, was the result of very careful consideration by a National Joint Committee representing in addition to our own Association, the American Telegraph and Telephone, the Western Union Telegraph, the Postal, the National Electric Light Association, and the American Institute of Electric Engineers. The telegraph and telephone interests felt they could not agree to joint use with lines at voltages above 5000, but with this exception the parties to the conferences accepted the principles set forth, one of which was that the pole pins should have a spacing of not less than thirty inches. Your Committee believes that the increasing tendency to joint use warrants considering it as the normal condition of the immediate future if not of today, and prescribe the thirty-inch pole pin spacing as the starting point. The other spaces are as short as seemed wise to make. The advantage of having arms in lengths of even feet was appreciated, but it was deemed more important

to have uniform pin spacings and a satisfactory combination of the two was not possible.

The sections given, 3¼ by 4¼ and 3¾ by 4¾, are common commercial sizes. We recognize that there are a great many cases where heavier arms are necessary, but for general service the two sections given will meet all requirements.

S. L. FOSTER:— I would like to ask Mr. Harte where the eye bolt shown on page 95 is intended to be used?

C. R. HARTE:— That is a wrought bolt.

S. L. FOSTER:— Do you not think that bolt should have a welded eye? A turned eye will not hold the strain with a heavy load. You specify somewhere that the anchor eye shall have the same strength as the rest of the rod, but a turned eye does not have that strength. You say on page 84 the "Guy anchor rods, for use in earth, must have at upper end an eye capable of developing full strength of rod." Should not the eyes of anchor rods used in rock have the same efficiency — the full strength of the rod?

C. R. HARTE:— If you look at page 111, you will see shown at the center of the top, the installation of the rock anchor bolt, and you will note that it is subjected not to a tensile stress, but to bending. That it is satisfactory is evident from the fact that it is the form used by the American Telephone & Telegraph Company and the Western Union Telegraph Company.

I would like to say that the Committee on Power Distribution, and every other committee, is charged not only with the specific matters assigned to it by the Executive Committee for the year, but also with the duty of going over the work that previous committees have done, to bring matters up to date. Too often members hesitate to question committee reports, particularly after the Association has acted upon them, but I am sure all of the Committees will welcome from any one comments and criticisms, particularly if constructive, on either current or past matters, and it should be remembered that no matter is past in the sense that it cannot be reopened. We do not care how much you pitch into a report, provided you will tell the committee how they can make their work better; it is only through the active, vigorous coöperation of you

men coming from various parts of the country, and having different conditions from some of the other fellows, in pointing out these differences and their influence upon your practice that we can make these specifications as they should be, broad gauge, and of a character to best serve the greatest number.

Just before I came away I received a letter from Vice President Carpenter of the American Cross Arm Company, questioning certain details of this specification. I want to say here that with the exception of the matter of lengths and pin spacing, the reasons for which have been already explained on the floor, there is nothing in the proposed specification that has not been standard for some time with the National Electric Light Association, The American Telegraph & Telephone Company, and the Western Union Telegraph Company. We have however, changed the form and the wording because we believed we could say the same things at least as clearly with fewer words.

Mr. Carpenter considers the specification unduly severe, but I think he, and any of you, will find, on careful comparison, that the requirements are in no wise except in wording changed from the former standards.

PRESIDENT CRECELIUS:— Just before asking you to vote on the question of the adoption of this Recommendation the Chair wishes to offer an explanation in connection with the points raised by Mr. Foster as regards all matters of this character. All that any Association can do in adopting Standards and Recommendations is to endeavor to provide specifications which, with certain modifications, may be applied to most conditions which are met. All that our Committee has done is to state a minimum value as to any given practice, which may be easily followed and it may be necessary, owing to certain ordinances and local conditions, to vary these specifications.

If there is no further discussion we will vote on the question of adopting the Specification for Overhead Line Material. Mr. Harte has already moved that the specification be adopted as a Recommendation.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— We will now take up the Specification for 600 volt D. C. Overhead Trolley Construction as shown on page 105 of this report. The Committee recommended for adoption new sections on Hub Guards, Guy Plates and Extension Arms, and amendments to a number of sections to supersede those in the present Specification.

W. G. GOVE:— The Committee on Standards has approved the amendments to the Recommended Specification for 600 volt D. C. Overhead Trolley Construction.

C. R. HARTE:— In moving the adoption of the recommendations I call your attention to the fact that the majority are additions covering the use of material described in the new material specification, while the remainder give fuller details than in the older form.

S. L. FOSTER:— The section Anchors in Earth has attracted my attention and we consider the use of a metal anchor plate preferable to one of wood and we have abandoned its use for the past twenty years. We prefer a galvanized wrought iron plate 18 in. square by ⅜ in. thick. It has about as many square inches of surface as the deadman specified and will last forever. The wooden deadman will gradually yield to the pressure of the anchor rod washer as the wood decays and finally some day it will let go altogether.

On page 107, Height of Trolley, we are compelled by local ordinance or tradition to maintain the trolley wire 22 ft. high over steam railroad crossings. The Committee says it shall be 21 ft.

As to Feed Taps, we use only double braid. The Committee recommends triple braid. The Committee recommends that the feed yoke shall be soldered. We use a clamp feed yoke, requiring no solder, and it has proven entirely satisfactory.

The Committee recommends that the ear be soldered, but we prefer a clinched ear. If one gets hot, we use two, and in some cases three. We are trying to get away from the use of solder on the trolley wire wherever possible.

E. J. BLAIR:—With respect to the height of trolley, I would like to call the attention of Mr. Foster to the exact wording in that regard. It says in paragraph 59, page 107, as follows:

"On trackage operating electric and steam road equipment and at crossings over steam roads the trolley wire shall be not less than twenty-one (21) feet above the top of rail, under conditions of maximum sag." If you have requirements calling for your trolley wire to be 22 feet above the ground, I do not think that there is anything incompatible in that.

With reference to double braid versus triple braid, the matter which Mr. Foster raised, I think he will agree that the triple braid is certainly a little bit better, and I believe that he would not object very strenuously to the specification for triple braid with that in mind. I have found out personally within the last few years that it does not pay me to buy any more double braid for certain classes of our service. I may buy cable and use some of it for this class of service, and some for heavy pulling over long distances, but it hardly pays me to carry in stock double braid and triple braid both. I think that Mr. Foster will probably pass that criticism.

C. R. HARTE:— Mr. Blair has answered the question as to the height of trolley wire. Twenty-one feet is given as the minimum, as there are certain states in which that is accepted; but there is nothing to prevent it being higher.

As to the use of an iron plate for a deadman it seems to me that the "patent anchor" clause gives the necessary latitude to bring in Mr. Foster's device. The idea was to set out the minimum of good practice, but to permit the use of equivalent or better devices if so desired. The question would be whether the advantages of the iron plate warranted the higher cost, and local conditions would have much to do with this.

In regard to the insulation for feeder taps, your Committee felt that triple braid was more nearly in line with the spirit of the Joint Pole Specification.

Mr. Chairman, through my oversight this report does not acknowledge, as it should, the invaluable assistance rendered by my Chief Draftsman, Mr. Guilford D. Young, and his assistant Mr. Clark, who made the drawings for the specifications. To them, and to Mr. Harry White and Mr. Shorthouse, this Committee and the Association are greatly indebted, and I desire to here record that fact.

PRESIDENT CRECELIUS:— We have had a rather complete

discussion on this particular matter, and if there is no further discussion we will put to vote the motion made by Mr. Harte that the amendments and additions to our Recommended Specification for 600 volt D. C. Overhead Trolley Construction be adopted.

(The motion was duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the amendments to the Recommended Specification for 600 volt D. C. Overhead Trolley Construction regarding lightning arrester location and grounds, Sections 81 and 82, as shown on page 104 of this report be adopted in lieu of present sections.

W. G. GOVE:— The Committee on Standards recommended that the proposed revisions of Sections 81 and 82 be approved and adopted to supersede present wording.

C. R. HARTE:— I move that the recommendation be approved.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the investigation regarding Reinforced Concrete Poles be continued and that the modified Specification as presented on page 68 of this report be used in place of that shown in the 1913 Proceedings, page 98.

W. G. GOVE:— The Committee on Standards voted that the Specification for Reinforced Concrete Poles as submitted be incorporated in Section Ds 3a of the *Engineering Manual.*

C. R. HARTE:— I move that the recommendation be adopted.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the Table for Deflection and Loads, and Pipe Table for Tubular Steel Poles, pages 76 to 81, be substituted for table shown in Section Ds 3a of *Engineering Manual,* and that it also be incorporated in the Standard Specification for Tubular Steel Poles (Section Ds 5a, *Engineering Manual*).

W. G. GOVE:— The Committee on Standards approves the recommendation of the Committee.

C. R. HARTE:— I move that the recommendation be adopted.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the Specification for Joint Use of Poles and drawings as approved by the American Association in 1914, be printed in the *Engineering Manual,* together with the resolution of that Association in accepting and approving this Specification.

W. G. GOVE:— The Committee on Standards approved the recommendation of the Committee on Power Distribution.

C. R. HARTE:— I move that the recommendation be approved.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is with regard to the Standardization Rules of the A. I. E. E., Sections 321–366; 379–381; 388–389; 404–414. The Committee on Power Distribution suggests that a definite division be outlined so as to determine where transmission system ends and distribution system begins.

W. G. GOVE:— The action of the Committee on Standards is as follows: Approved suggestion of the Committee and in view of the fact that these rules have been further revised by the A. I. E. E. since their consideration by the Committees, the new issue bearing date of July 1, 1915, that this subject be given further consideration.

C. R. HARTE:— I move that the recommendation be adopted.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The report is now open for general discussion. I am, unfortunately, not acquainted with many of the gentlemen I see here, and I hope you will exercise your prerogative and rise to speak on this report. Mr. Foster have you anything further to say?

S. L. FOSTER:— I appreciate the admirable report presented by this Committee. I am not at all in a critical mood. All I wanted to do is to point out that some of the matters described in the report are different from our practice here. I thought that it might be of interest to the gentlemen present. We represent only a small part of the country and do not have much weight. The work in the East is different from ours, and we do not seem to have much influence when we express our views about specifications.

PRESIDENT CRECELIUS:— I hope we can expel that feeling. We try to prescribe a minimum as good practice.

S. L. FOSTER:— Would it not be well for that to be put in the literature? You could so prescribe, that it is a minimum condition, above which any one could go. Our practice differs usually in being stronger than that specified by the Committee.

PRESIDENT CRECELIUS:— That can be done.

S. L. FOSTER:— I move that the report be accepted and a vote of thanks extended to the Committee.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— Mr. Drew, may we hear from you?

JAMES H. DREW:— When you asked me, Mr. President, if I had something to say, I felt I had no right to speak in this meeting, and for that reason I was only going to speak as a visitor. I do not think it would be a proper course for me to offer any criticisms or any suggestions to any official action this Association might take. I have had the pleasure of meeting a great many of the gentlemen in their offices and in their individual capacities from time to time.

I have one or two thoughts that came to me, which I want to leave with you, and while it may seem open flattery I want you to take it in a different light. The thought is this — that the principles and practices for securing finances to build public utilities are changing rapidly.

The valuation and regulation of public utilities by municipal, state or federal bodies are becoming more strict; therefore your responsibilities are much greater than they were a few years ago. In the building of such utilities, and in the operation of them, the Engineering Association can take credit for a large share of the operation. You are not only building for today, but you are building for the future and the building you do now will have to pass the scrutiny, not only of financiers now, but of regulating bodies a few years hence. It was this view of standardization that I had in mind, Mr. President — the sooner the Engineering Association can reach a harmonious interchange of ideas and adoption of these ideas, the better properties you will build. You

will make more certain the value and efficiency of the various properties with which you are each individually connected.

I think the work of this Convention, Mr. President, has been a great achievement in the adoption of these reports. After you have adopted them you have created a Standard that is universal, allowing of course for the few cases of geographical and climatic exceptions that must be made, where conditions are not quite the same.

You must build for the future as well as for the present. There must be some adopted and recognized standard practice of engineering that will create a force, not in one section, but all over the country — a code that will make the regulating bodies, the financiers and the operators of electric railways recognize the factors that enter into their construction.

These adopted standards will represent the meeting of many minds — minds of men trained in this particular art and if they have the prestige of the American Electric Railway Engineering Association back of them they will carry weight and conviction to those who inquire into the physical value of your various properties.

My plea then is to arrive at a common universal standard of practice in the selection and use of materials and in the art of construction. It is to be hoped that you will all use your best efforts to bring about the few necessary compromises required by local conditions, so that the railroads may stand for principles and practices that will be of the greatest good to the greatest number.

PRESIDENT CRECELIUS:— We are happy to see the manufacturers in the frame of mind you indicate. Gentlemen, is there any further discussion of this report? Are there any closing remarks you desire to make, Mr. Blair?

E. J. BLAIR:— I want to reiterate the thanks of the Committee to Mr. Foster. It is rather discouraging to spend considerable time working on a proposition, and then have nobody say anything for or against it. I for one would rather have somebody say something against a report than to keep still, that at least shows they are paying attention to the work that has been done. I also want to call to Mr. Foster's attention the fact that this seeming difference between the East

and the West will probably be considerably overcome by having had this Convention in San Francisco. I believe that aside from other considerations that particular one would certainly justify the selection of San Francisco as the place for this meeting.

PRESIDENT CRECELIUS:— This has been a very comprehensive report. The Committee has done an unusually large amount of good work. If there is no further business the meeting will stand adjourned.

TUESDAY SESSION

OCTOBER 15, 1915

Joint Session with Transportation and Traffic Association

President Brush of the Transportation and Traffic Association called the meeting to order at 2:15 o'clock P. M.

PRESIDENT BRUSH:— The meeting this afternoon opens with a joint session with the Engineering Association. President Crecelius of the Engineering Association has very kindly consented to preside.

PRESIDENT CRECELIUS:— The first business to come before the meeting is the Report of the Joint Committee on Block Signals for Electric Railways. In the absence of Mr. J. M. Waldron, the Chairman, the report will be presented by Mr. H. A. Nicholl.

Mr. Nicholl read the recommendations of the Committee as approved by the Committee on Standards, appearing on page 224 of the report, as well as that part of the report bearing on conclusions that appear on page 199.

REPORT OF THE JOINT COMMITTEE ON BLOCK SIGNALS FOR ELECTRIC RAILWAYS

To the American Electric Railway Engineering and the American Electric Railway Transportation and Traffic Associations:

GENTLEMEN:— Your Committee was instructed by the Executive Committee of the Engineering Association to consider and report on the following subjects:

(*a*) Digest of Signal Laws and Rulings. This should show if any State Commissions made new rulings subsequent to date of information in 1914 report.

(*b*) Bibliography on Block Signal installations — subsequent to June 1, 1914.

(*c*) Design of Standard Signal Apparatus. To coöperate with Railway Signal Association Committee on Signaling for Electric Railways in the adoption of Standard Signal Apparatus.

(*d*) Clearance Diagram for Semaphore Signals. This should be considered after conference with Committee on Power Distribution and Heavy Electric Traction.

(*e*) Revision of Block Signal Rules for Contactor Signals. This to be considered jointly with Committee on Rules of Transportation and Traffic Association, as Rule 10 was referred back to Committee.

(*f*) Light Signals for Interurban Railways. Should be given further consideration with a view to the adoption of a definite standard for sizes of lenses for light signals operated by continuous track circuit or contactors.

(*g*) On the advisability of Changing Standard Light Aspects in Three Position Signaling to read from "Non-Car Counting" or "Car Counting" to "Non-Registering" or "Car Registering" Signals, as new contactor signal rules all read "Car Registering Signals".

(*h*) Study of Signal Systems on Roads that are signaled from end to end to cover maintenance, cost, efficiency of operation and effect on traffic.

(*i*) Review all existing Standards and Recommendations, originating with the Committee on Block Signals for Electric Railways.

(*j*) Consider the Standardization Rules of the American Institute of Electrical Engineers, so far as they affect the scope of your Committee. In the event that any rule is not approved, a recommended revision should be submitted.

The following subjects were assigned by the Executive Committee of the Transportation and Traffic Association for investigation, by the Joint Committee.

(*k*) Investigate the question of a standard definition for signal failure.

(*l*) Make a general study and summary of highway crossing protection.

(*m*) Report as to the advisability of operating without dispatching single track interurban lines which are blocked by signals alone.

MEETINGS

Your Committee has held two meetings during the current year, and several meetings of the sub-committees. The first meeting convened at the offices of the Public Service Railway Co., in Newark, N. J., on December 10, 1914, at which were present: J. M. Waldron, *Chairman,* J. W. Brown, *Co-Chairman,* C. D. Emmons, C. H. Morrison, John Leisenring, and G. N. Brown. H. H. Norris, of the *Electric Railway Journal,* acted as Secretary. At this meeting all of the subjects assigned were discussed, and the following sub-committees appointed for investigation and report:

Subject (a) Mr. A. E. Roome.
Subject (b) Mr. H. H. Norris.
Subject (c) Messrs. Morrison and Waldron.

Subject (d) Messrs. Leisenring and G. N. Brown.
Subject (e) Messrs. Emmons and Nicholls.
Subject (f) Messrs. Leisenring, Nicholls and Morrison.
Subject (g) Messrs. J. W. Brown and Morrison.
Subject (h) Messrs. G. N. Brown and J. W. Brown.
Subject (i) Messrs. Morrison and Waldron.
Subject (j) Messrs. G. N. Brown and Waldron.
Subject (k) Mr. A. E. Roome.
Subject (l) Messrs. Leisenring, Nicholls and J. W. Brown.
Subject (m) Messrs. J. W. Brown and Leisenring.

Sub-committees held a meeting at the Association Headquarters in New York, on January 26 and 27, 1915, at which were present: J. M. Waldron, *Chairman,* J. W. Brown, *Vice-Chairman,* and G. N. Brown. H. H. Norris and F. Kingsley, representing the *Electric Railway Journal,* and representatives of different signal manufacturers were present as follows: Messrs. S. M. Day, General Railway Signal Company, H. W. Griffin, Union Switch and Signal Company, R. V. Collins, United States Signal Company. In addition to the above Mr. C. L. Cadle, of the New York State Street Railways, assisted the sub-committees in their work.

On January 11, 1915, at the Congress Hotel, Chicago, a meeting was held of sub-committees having in charge the subjects of "Revision of Contactor Signal Rules", "Change of Phraseology of Light Aspects for Contactor Signals", "Highway Crossing Protection" and "Operation by Signal Indication without Dispatcher on Single Track".

There were present at the meeting: Messrs. C. D. Emmons, H. A. Nicholl, John Leisenring and J. W. Brown, *Co-Chairman.* L. E. Gould of the *Electric Railway Journal* acted as Secretary and Messrs. M. H. Hovey and W. W. Talbert also were in attendance.

The second meeting of your Joint Committee was held at the Congress Hotel, in Chicago, on March 16, 1915, at which were present: J. W. Brown, *Vice-Chairman,* C. D. Emmons, H. A. Nicholls, C. H. Morrison, J. Leisenring, G. N. Brown, also L. H. Palmer, C. E. Morgan, and S. W. Greenland, members of the Committee on Rules and constituting the sub-committee to confer with your Committee on the subject of block signal rules. Representatives of the different signal manufacturers were also present as follows: Messrs H. W. Griffin, Union Switch and Signal Company, S. M. Day, General Railway Signal Company, W. J. Field, of *Electric Traction,* and E. M. Haas of the *Electric Railway Journal.* Mr. L. E. Gould of the *Electric Railway Journal,* was also present and acted as Secretary of the meeting.

At this meeting, by correspondence and sub-committee meetings, your Committee has drafted the following report:

DIGEST OF BLOCK SIGNAL LAWS

This subject has received consideration from the Committee for several years and references to the work accomplished heretofore, is given as a matter of record. In 1911 the Committee prepared a digest of Federal and State laws compelling the installation of block signals on electric railways or conferring the necessary authority upon the various State Commissions to require electric railways to install block signals. This digest also included rulings made by the different commissions on this subject. (See 1911 Proceedings, Engineering Association, pages 193–199; Transportation and Traffic Association, pages 226–232.)

In 1912 the Committee made a study to determine what states had laws and rulings upon the general subject of block signals. (See 1912 Proceedings, Engineering Association, pages 202–204; Transportation and Traffic Association, pages 110–112.)

In 1913 the Committee made a further study of State laws on block signals and safety devices as well as different rulings by the various State railroads and public utility commissions on all safety devices pertaining to railroad operation. (See 1913 Proceedings, Engineering Association, pages 201–205; Transportation and Traffic Association, pages 188–192.)

In 1914 the Committee again considered this subject and submitted a Summary of Replies received from the various State Commissions. (See 1914 Proceedings, Engineering Association, pages 167–172; Transportation and Traffic Association, pages 193–198.)

Your Committee has been unable this year to make a complete study of this subject and recommends that it be considered further by the ensuing Committee, to cover not only any laws and rulings that have been made during the year June 1, 1914 to June 1, 1915, but to cover the period June 1, 1914, to June 1, 1916.

BIBLIOGRAPHY ON BLOCK SIGNALS

The 1913 Committee with the aid of Mr. A. D. Cloud of *The Signal Engineer,* prepared a comprehensive bibliography (see 1913 Proceedings, Engineering Association, pages 277–298; Transportation and Traffic Association, pages 244–265) on the subject of block signals and in 1914 the Committee, with the co-operation of Mr. L. E. Gould of the *Electric Railway Journal,* prepared a supplement which appeared as Appendix B of the report, bringing the previous bibliography up to date of June 1, 1914. (See 1914 Proceedings, Engineering Association, pages 206–211; Transportation and Traffic Association, pages 232–237.)

Your Committee is able this year through the courtesy of Mr. H. H.

Norris of the *Electric Railway Journal* to again present a comprehensive supplement to this bibliography covering not only Block Signals but Highway Crossing Signals as well. The bibliography is divided into three parts: (a) Block Signals; (b) Highway Crossing Signals; (c) Sundry, etc., which covers all articles that pertain in a general way to the subject of Block Signals.

This bibliography covers articles appearing in engineering periodicals from June 1, 1914 to July 1, 1915, and your Committee hopes that the membership will find this to be a valuable adjunct to those printed in connection with previous reports. The bibliography is found as Appendix **A** of this report.

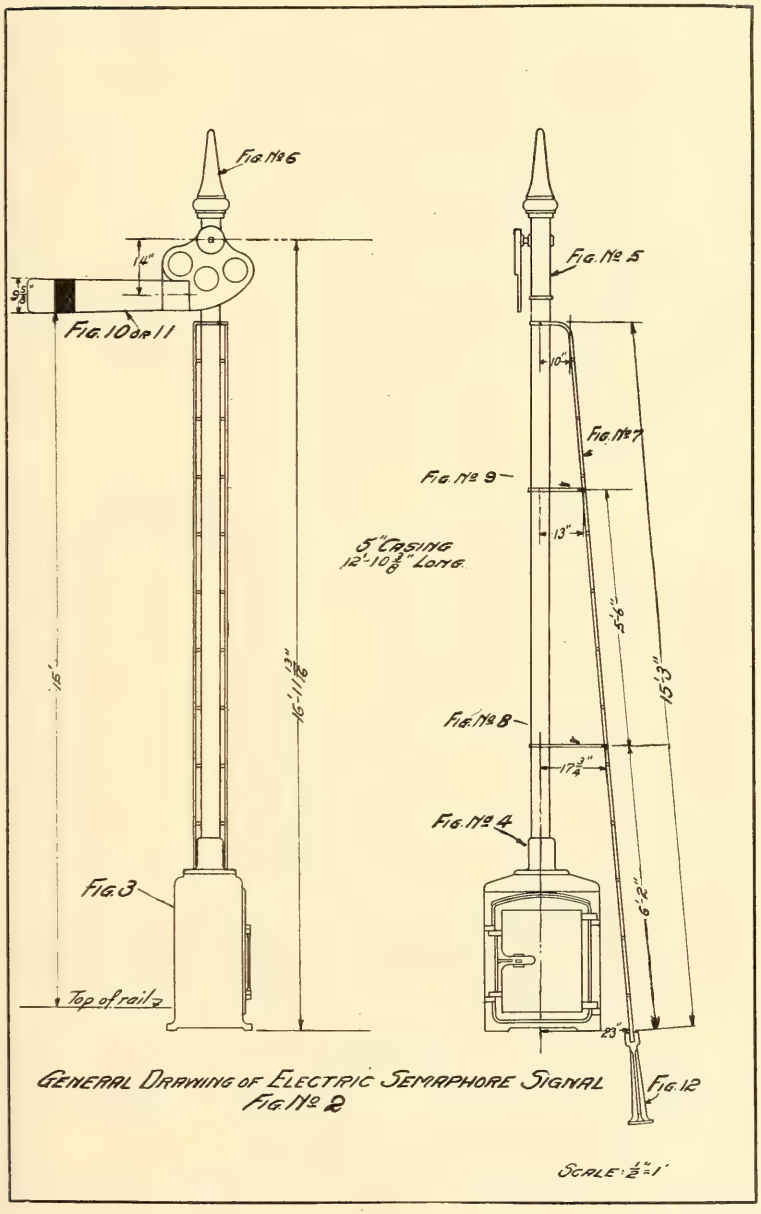
In addition to the above, there is appended a short abstract of information concerning signal installations made by various manufacturers during the past year. This information has been furnished by the various signal companies and covers that part of the report which in former years has been of much interest to companies having signal installations.

DESIGN OF SIGNAL APPARATUS

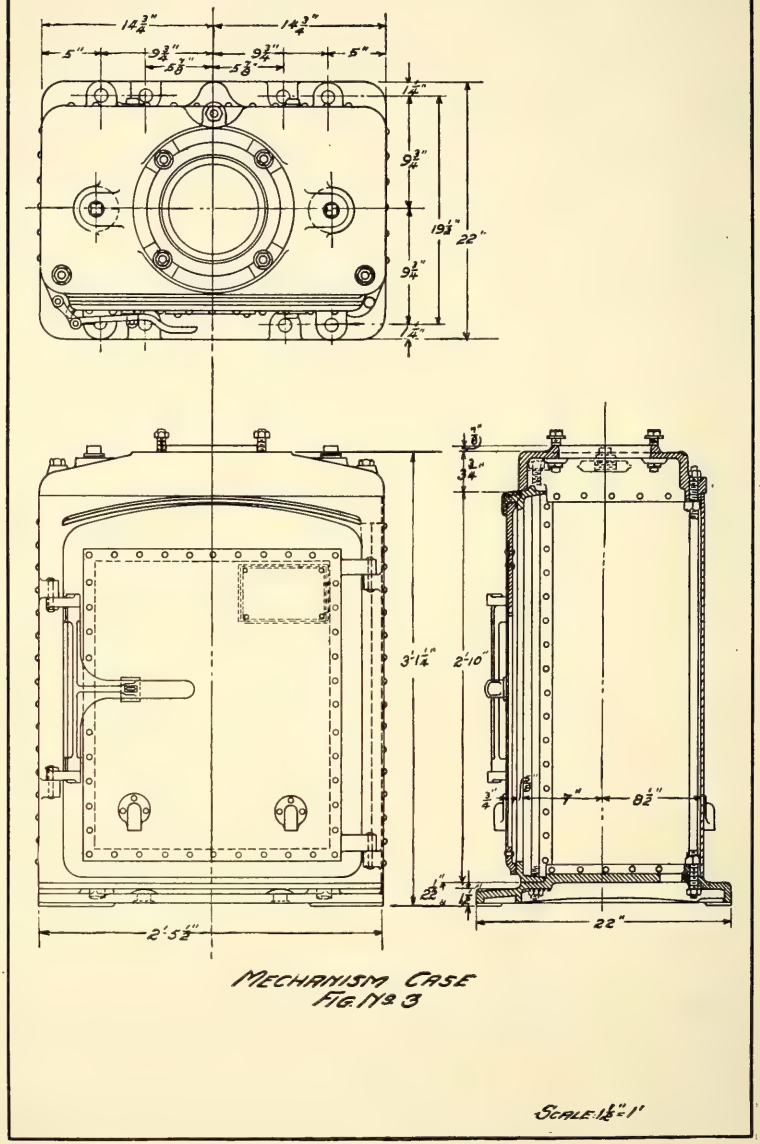
The question of submitting designs for Signal Apparatus was given consideration for the first time last year when a design for a semaphore spectacle for a left-hand upper quadrant 90 degree semaphore, having 6 in. openings and 6½ in. lenses for three-position semaphore signals, and for use with a 3 ft. 6 in. pointed blade was prepared and recommended for adoption. (See 1914 Proceedings, Engineering Association, page 173; Transportation and Traffic Association, page 199.) Your Committee this year through a sub-committee composed of Messrs. Morrison and Waldron conferred as instructed with the Railway Signal Association on the subject of Design of Signal Apparatus with a view to adopting such of the designs of that Association as would be applicable to Electric Railways. It was found, however, that the designs of the Railway Signal Association would not in all cases fit electric railway operation and your Committee has therefore modified these designs so as to make them applicable to electric railway service and submits herewith for adoption as Standard a Design of Semaphore Signal* (Fig. 2) with details of each part shown separately. (Figs. 3 to 12.)

Your Committee also recommends that further study be made of this subject by the ensuing Committee with a view to recommending additional designs of signal apparatus for adoption.

*Formally approved by both the Committee on Standards and the 1915 Convention as Standard.

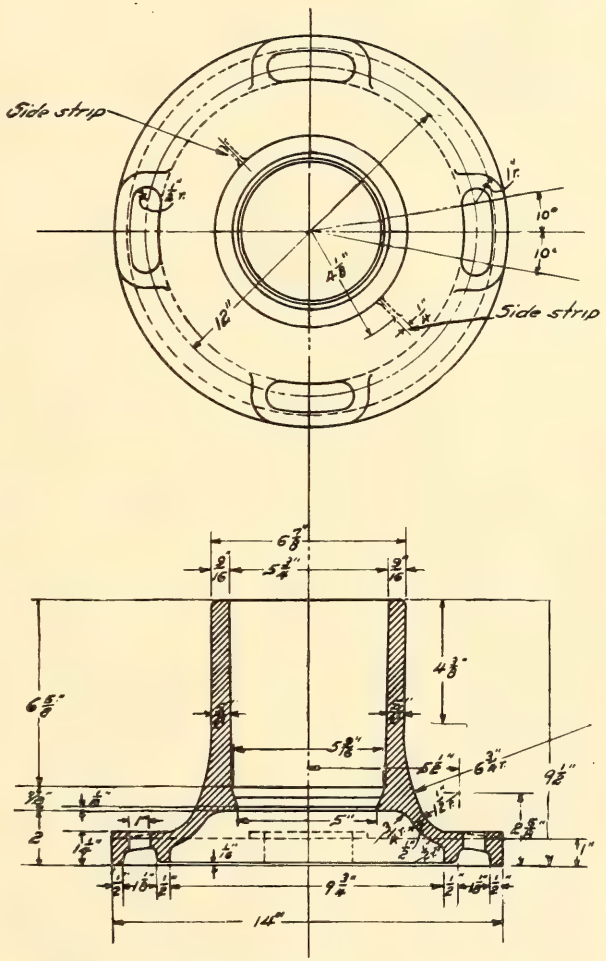


GENERAL DRAWING OF ELECTRIC SEMAPHORE SIGNAL
FIG. No 2



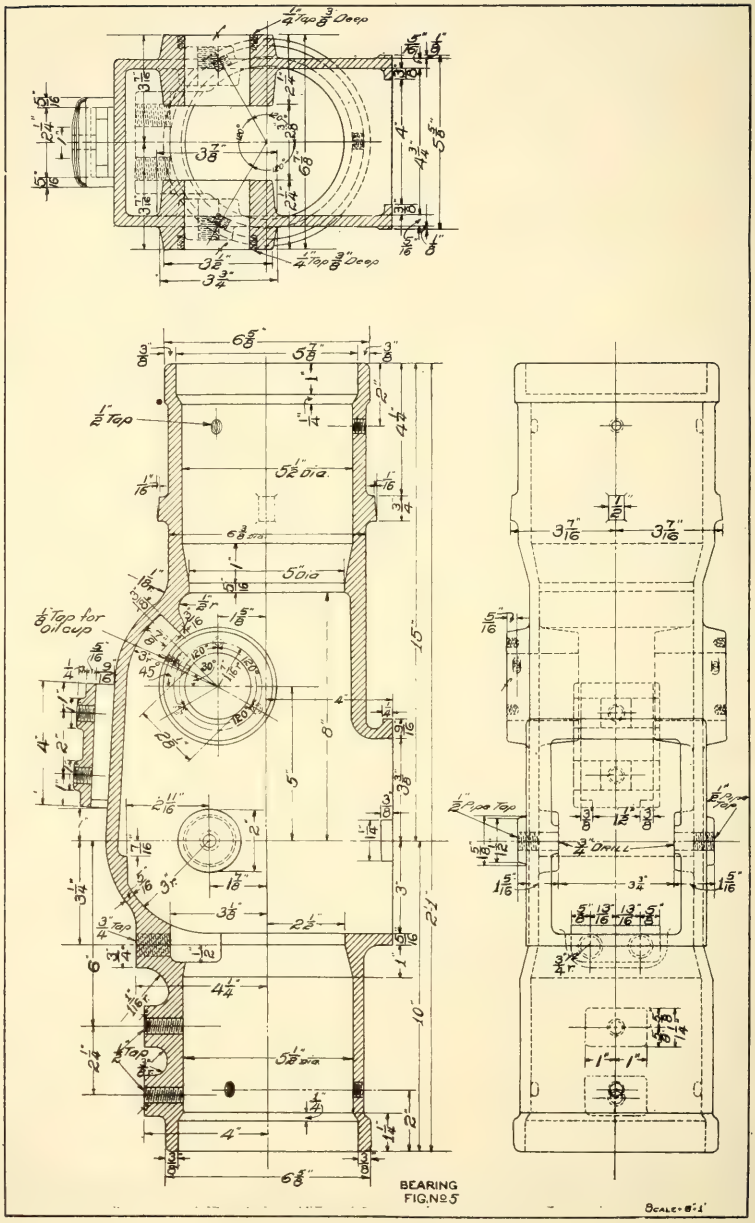
MECHANISM CASE
FIG. NO 3

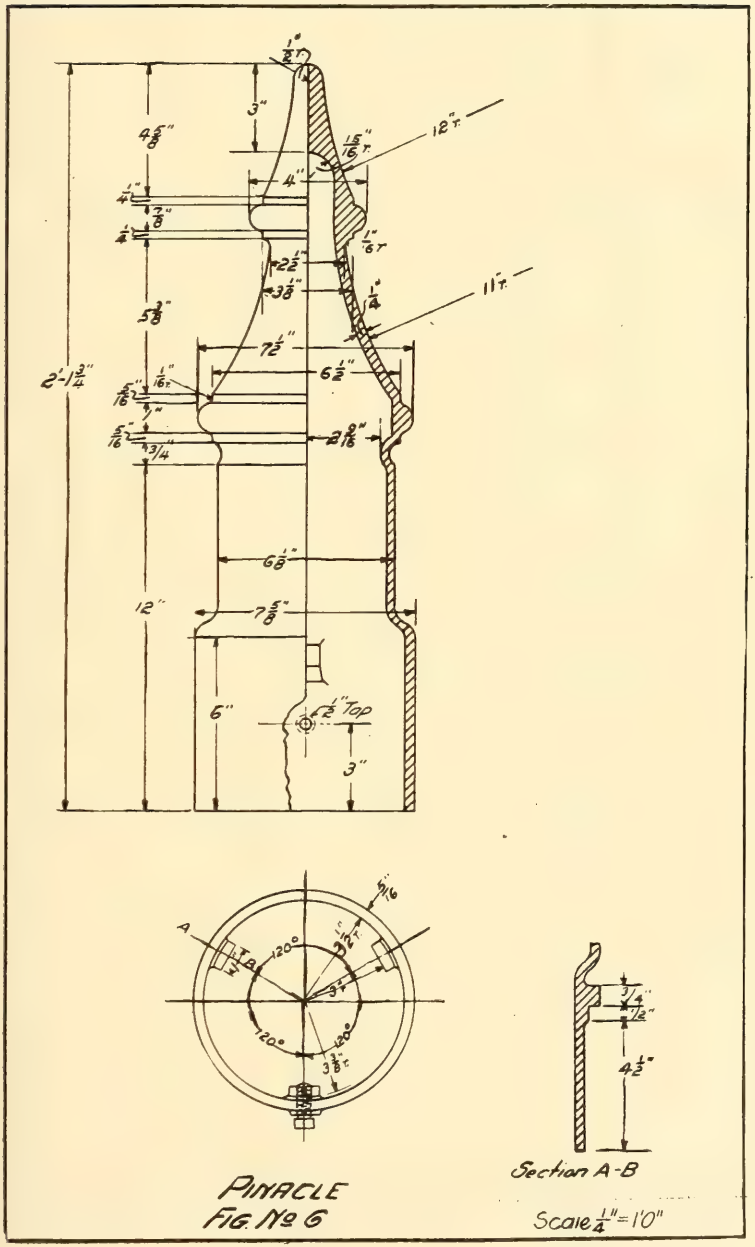
SCALE: 1 1/2" = 1'



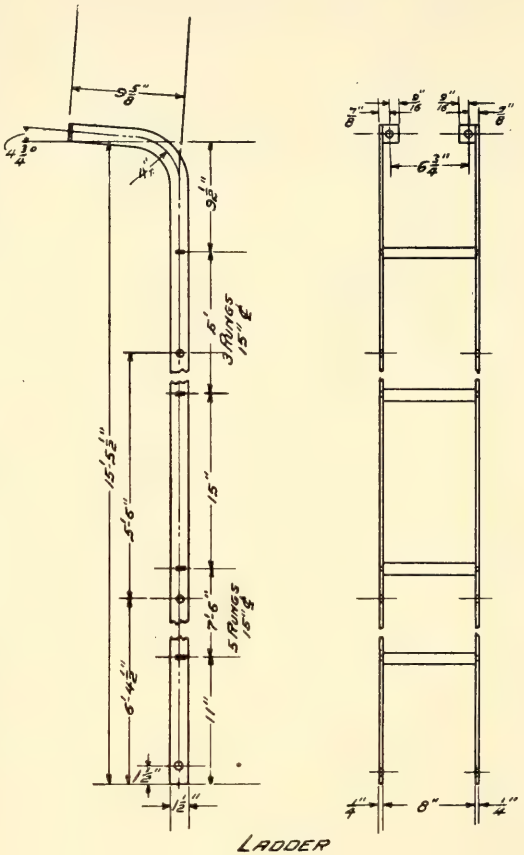
C.I. MECHANISM CASE PIPE SOCKET FOR 5" CASING
FIG. NO 4.

Scale ¼" = 1'0"


BEARING
FIG. No 5
SCALE - 6" = 1'



PINACLE
FIG. No 6



LADDER
FIG. No 7

SCALE ½"=1"

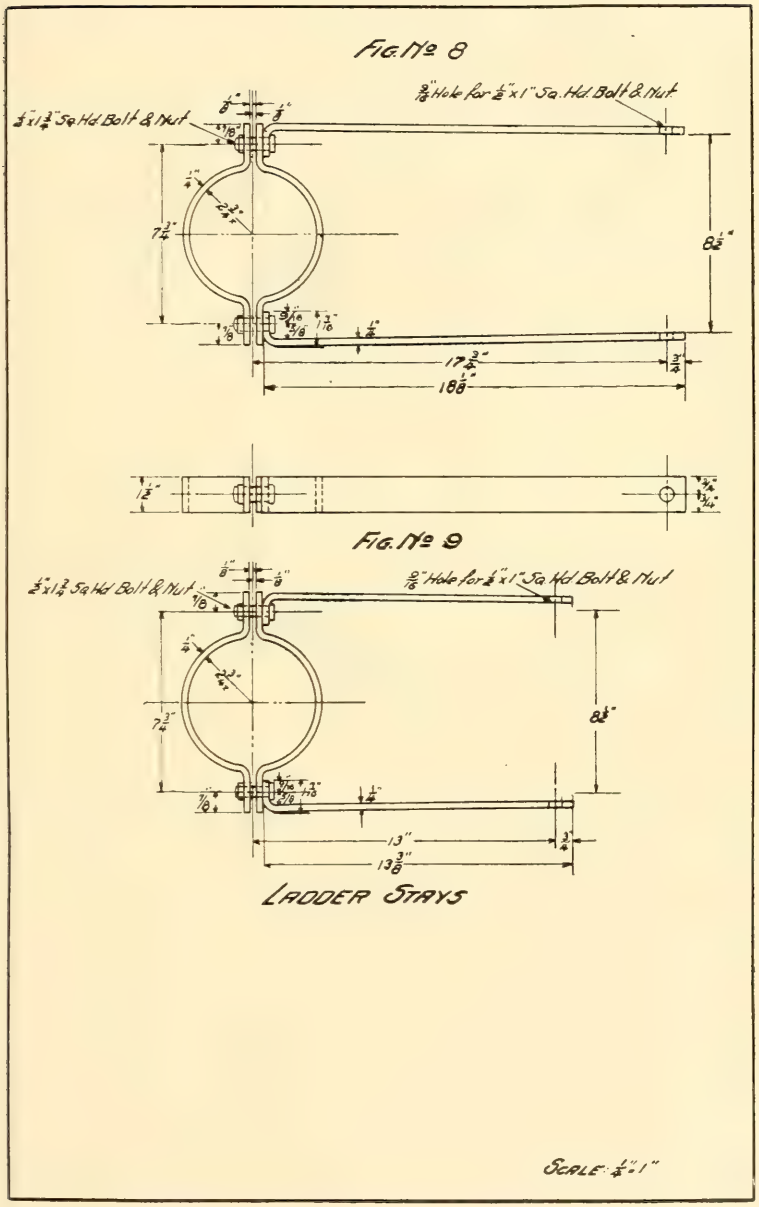


FIG. No 8
⅝" Hole for ½" x 1" Sq. Hd Bolt & Nut
½" x 1¾" Sq Hd Bolt & Nut
⅝"
⅛"
¼"
2¾"
7¾"
8½"
⅛"
⅜"
1"
17⅜"
¾"
18⅛"
1½"
¾"
1¾"
FIG. No 9
⅝" Hole for ½" x 1" Sq. Hd Bolt & Nut
½" x 1¾" Sq Hd Bolt & Nut
⅝"
⅛"
¼"
2¾"
7¾"
8½"
⅛"
⅜"
1"
13"
¾"
13⅜"
LADDER STAYS
SCALE: ½" = 1"

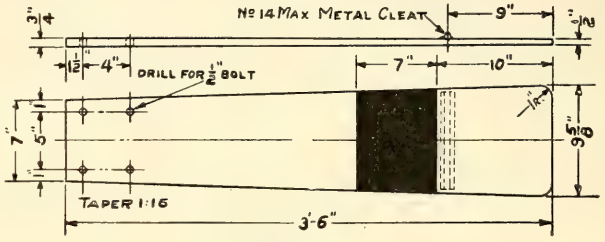


Fig 10

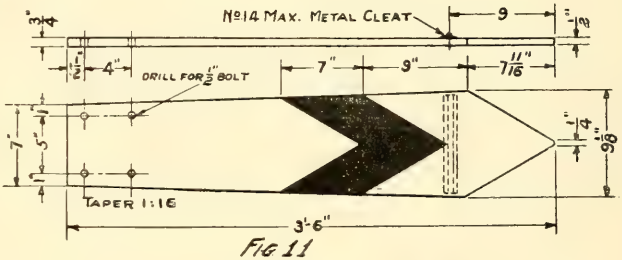


Fig 11

Blades

—PAINTING—

PAINT FRONT **RED** WITH **WHITE** STRIPE
PAINT BACK AND EDGES **BLACK**

Scale: 1 1/2" = 1'

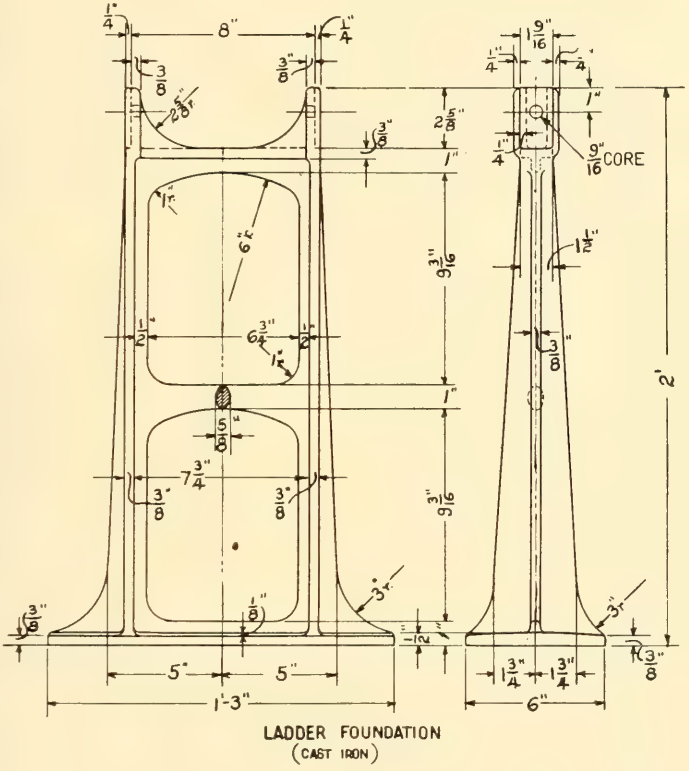


FIG. Nº 12

CLEARANCE DIAGRAM FOR SEMAPHORE SIGNALS

Your Committee last year submitted a signal clearance diagram showing location of signal masts and semaphores with reference to trolley poles, etc., for use on electric roads for adoption as Standard. (See 1914 Proceedings, Engineering Association, page 173; Transportation and Traffic Association, page 199.) On the floor of the Convention it was brought out that this diagram did not conform to the clearances as required by the Recommended Specification for 600-Volt Direct Current Overhead Trolley Construction and as a result this subject was referred back to the Committee with instructions to coöperate with the Committees on Power Distribution and Heavy Electric Traction in order that the various standards proposed may be in harmony. (See 1914 Proceedings, Engineering Association, page 242; Transportation and Traffic Association, page 268.)

Your Committee this year in accordance with instructions, appointed Mr. John Leisenring of the Committee on Block Signals and Mr. G. N. Brown of the Committee on Power Distribution a sub-committee to prepare a new clearance diagram as shown in Fig. 13, eliminating the undesirable features shown on last year's diagram. For instance the Interstate Commerce Commission's car outline has been eliminated and the maximum car outline, as adopted by the American Railway Association and the Committee on Heavy Electric Traction of this Association, has been made our Standard. All dimensions on the diagram are minimum and are shown to face of pole or bottom of bracket, as the case may be, and not to center line. Both square and pointed semaphore blades are shown, together with pantagraph clearance lines.

On this diagram the trolley wire is not shown but the trolley bracket has a minimum height of 20 ft. There is a note which applies to this dimension as follows: "For brackets supported from poles on same side of track as semaphore when within 300 ft. of signal." For a road having an 18 ft. trolley this permits retaining the same height of trolley at a signal location, although the brackets are to be raised to 20 ft., or the trolley wire can be raised to follow the brackets if this is desired. With the bracket at this height, 20 ft., the full length of the semaphore blade when in the *clear* position can be sighted fully 1,000 ft. in advance of the signal. This height of bracket is considered as an absolute minimum when the view of the semaphore blade is considered.

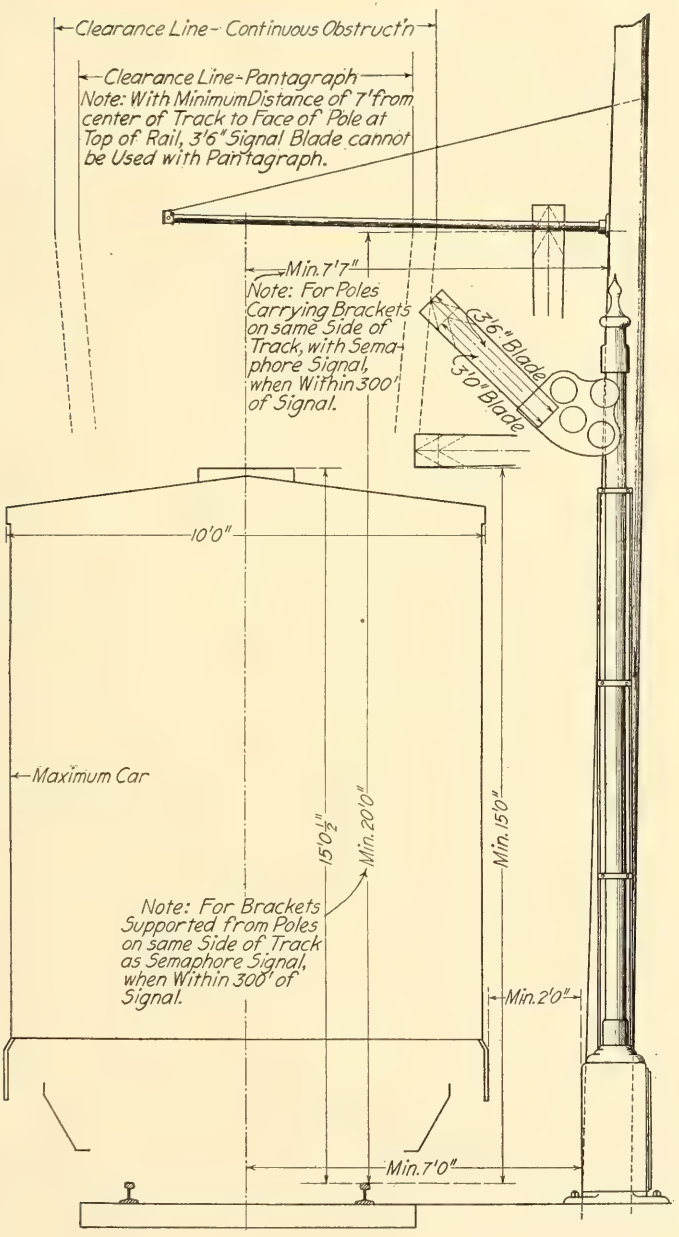
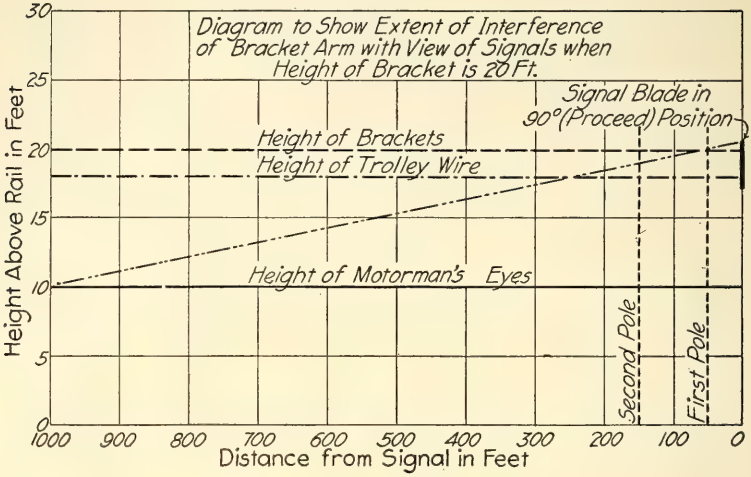

Clearance Line - Continuous Obstruct'n
Clearance Line - Pantagraph
Note: With Minimum Distance of 7' from center of Track to Face of Pole at Top of Rail, 3'6" Signal Blade cannot be Used with Pantagraph.
Min. 7'7"
Note: For Poles Carrying Brackets on same Side of Track, with Semaphore Signal, when Within 300' of Signal.
3'6" Blade
3'0" Blade
10'0"
Maximum Car
15'0½"
Min. 20'0"
Min. 15'0"
Note: For Brackets Supported from Poles on same Side of Track as Semaphore Signal, when Within 300' of Signal.
Min. 2'0"
Min. 7'0"

FIG. 13. CLEARANCE DIAGRAM FOR SEMAPHORE SIGNALS.

There is included herewith a diagram,



which shows the extent of interference of bracket arms with view of signals when height of bracket is 20 ft.

In regard to pantagraph clearances it will be noted, as explained on the diagram, that a 3ft. 6 in. blade cannot be used, but where pantagraphs are used the blades must be shortened to 3 feet.

As stated above the outline of the maximum car is that of the American Railway Association and shows an 8 in. clearance between top of car and semaphore blade when in the *stop* position.

The clearance between step of car and any attachment which might be placed on the trolley pole or signal mast, such as ladder, relay box, etc., is shown as minimum 2 ft.

In order to insure against any obstruction of the view of the signal by the trolley poles, it has been deemed advisable to establish as a minimum the distance of 7 ft. 7 in. from center line of track to face of pole at a height of 20 ft. above top of rail. This is to apply to any and all classes of poles and consequently a note applying to this dimension and reading as follows has been added.

"For poles carrying brackets on same side of track with semaphore signal when within 300 ft. of signal."

Your Committee recommends this Clearance Diagram for adoption as a Standard.*

BLOCK SIGNAL RULES

The subject of Block Signal Rules first received consideration in 1913 by a subcommittee of the Committee on Block Signals for Electric Railways in conjunction with a sub-committee of the Committee on Interurban Rules. This joint sub-committee drafted a set of Automatic Block Signal and Interlocking Rules supplementary to the Standard Code of Interurban Rules which was presented at the 1913

* See page 224 for Action of Committee on Standards.

Convention and there approved. (See 1913 Proceedings, Engineering Association, pages 257-276; Transportation and Traffic Association, pages 115–138).

In 1914 your Committee again coöperated with the Committee on Rules of the Transportation and Traffic Association in the consideration of a set of Contactor Signal Rules (1914 Proceedings, Engineering Association, p. 173; Transportation and Traffic Association, p. 199).

This year your Committee has again joined with the Transportation and Traffic Association in the consideration of this subject and at the meeting held in Chicago on March 16 and 17, 1915, a Sub-committee from the Committee on Rules consisting of Messrs. C. E. Morgan, S. W. Greenland and L. H. Palmer, took up with your Committee the revision of the rules and definitions pertaining to block signal operation. As it was not possible to finish this work at that meeting, a Sub-committee from the Committee on Block Signals, composed of Messrs. C. D. Emmons and G. N. Brown, was appointed to meet with the Sub-committee from the Committee on Rules and finish the work.

This Joint Sub-committee held a meeting at the Association headquarters in New York on April 7, 1915, at which there were present Messrs. J. W. Brown, J. M. Waldron and C. D. Emmons from the Committee on Block Signals, Messrs. C. E. Morgan and L. H. Palmer from the Committee on Rules, and Mr. S. M. Day, of the General Railway Signal Co.

At this meeting the Interlocking and Automatic Block Signal Code as well as the Contactor Signal Rules were carefully considered.

The Subject of Contactor Signal Rules referred particularly to Rule 10 — under Signal Rules as presented by the Joint Committee on Block Signals at the 1914 Convention. In connection with this rule your Committee recommends that it be restricted to non-registering type signals only and a clause to this effect is inserted in parenthesis after the rule number.

The complete code of signal rules, covering all types is given below but your Sub-committee, however, recommends this revision be presented to the Transportation and Traffic Association, merely as a progress report to be used where present need exists for the guidance of member companies.

The whole question of signal procedure is undergoing change at this time due to the development of the art. At present a committee of signal engineers is working on a new signal rules code to present to the A. R. A. for their consideration. This committee is working especially to define precisely the several words and phrases used in definitions and rules, so that uniformity of terminology may be had; at the present time in signal work this is of utmost importance. It would be very desirable if it could be arranged to have a joint committee between the two Associations on this subject, or at least an accredited representative of the A. E. R. A. on the committee of the A. R. A. when the signal rules are revised, and your Committee recommends this matter be taken up at once.

Signal Rules

SUPPLEMENTING

STANDARD RULE BOOK

GOVERNING OPERATION BY SIGNALS

FOR USE OF EMPLOYES

OF THE

_____ Company

(date)

Signal Rules Supplement

RULE BOOK NO. _____

THIS BOOK IS THE PROPERTY OF THE

_____ **Company**

AND IS ISSUED TO

Name _____

Position _____

Division _____

Who hereby agrees to return it to the proper officer of the Company when called for, or upon leaving the service.

Signal Rules

SUPPLEMENTING

STANDARD RULE BOOK

GOVERNING OPERATION BY SIGNALS

FOR USE OF EMPLOYES

OF THE

_____ Company

(date)

GENERAL NOTICE

The rules herein set forth govern the use of .....* signals on railroads, operated by ..... Company. These signals are installed to safeguard the movement of trains. These rules take effect ....., superseding all previous rules and instructions inconsistent therewith. Notice will be issued when signals or switches are to be placed in or taken out of service.

In addition to these rules, special orders will be issued from time to time. Such orders when issued by proper authority, whether in conflict with these rules or not, must be obeyed while in force.

*Individual companies should insert here the name of the signals for which the rule are issued, i. e., automatic block, contactor or interlocking signals.

GENERAL DEFINITIONS

(NOTE: The following embodies the Joint Sub-committee's recommendation as to order to be followed.

To go in front of Signal Code after General Notice, to be followed by Interlocking, Automatic Block and Contactor Rules in order named. Under each of the three headings the order to be followed is (1) Definitions; (2) General Rules; (3) Rules for Trainmen; (4) Rules for Signal Operators [this last refers only to Interlocking Rules].)

Fixed Signal

A signal of fixed location indicating a condition affecting the movement of a train

Semaphore Signal

A fixed signal whose indications are given by the position of a movable arm.

Dwarf Signal

A low fixed signal of semaphore type.

Pot Signal

A small revolving fixed signal used as a substitute for a dwarf signal.

Disc Signal

A fixed signal whose indications are given by the position or color of a disc.

Light Signal

A fixed signal in which the indications are given by the color of a light.

Home Signal

A fixed signal at the point at which trains are required to stop when the route is not clear.

Intermediate Home Signal

A home signal located between sidings used to subdivide that length of track into following blocks and to indicate whether the section of track governed is occupied.

Home Auxiliary Signal

A home signal located between sidings used only to indicate whether the track to the opposing home signal at the next siding in advance, is occupied.

Distant Signal

A fixed signal used in connection with home signals to regulate the approach thereto.

Cab Signal

A signal giving indications in the motorman's cab.

Switch Target

The target connected to and working with a switch to indicate the route for which the switch is set.

Distant Switch Signal

A fixed signal used in connection with a switch target to regulate the approach thereto.

Crossing Signal

A fixed signal used at a railroad grade crossing to indicate by the position of an arm, gate, ball, target or light the train which may use the crossing.

Train Order Signal

A fixed signal used in connection with the movement of trains by train orders.

Signal Indication

The information conveyed by the position or color of the signal arm, disc or lights displayed.

Clear Signal

A signal indicating *Proceed* or *Continue.*

Caution Signal

A signal indicating *Proceed with Caution, at Slow Speed, Prepared to Stop.*

Stop Signal

A signal indicating *Stop.*

Block

A length of track of defined limits between the home signal at one siding and the opposing home signal at the next siding on single track, or between home signals on double track, and at interlocking plants, the use of which by trains is controlled by fixed signals.

Block Signal

A fixed signal controlling the use of a block.

Following Block

In single track operation that part of a block between home signals governing movements in the same direction.

Absolute Block

A block in which but one train is allowed at any time.

Permissive Following Block

A section of track which two or more trains running in the same direction are permitted to occupy at the same time under a permissive indication.

Clear Block

A block not occupied by a train.

Block System

A series of consecutive blocks.

Manual Block System

A series of consecutive blocks, controlled by block signals operated manually, upon information by telegraph, telephone or other means of communication.

Controlled Manual Block System

A series of consecutive blocks controlled by block signals operated manually upon information by telegraph, telephone or other means

of communication, and so constructed as to require the coöperation of the signalmen at both ends of the block to display a clear or a caution signal.

Automatic Block System

A series of consecutive blocks controlled by block signals operated by electric, pneumatic or other agency, actuated automatically by a train or by certain conditions affecting the use of a block.

Permissive Signal

A fixed signal which allows a train to enter a section of track of defined limits already occupied by a train running in the same direction.

Block Station

A place from which block signals are operated.

Repeater

A device to show the indication of a fixed signal.

Track Indicator

A device to indicate to a signal operator whether or not a certain section of track is occupied.

Switch Indicator

A miniature signal located at a switch point indicating whether or not the block is occupied or a train is approaching.

In the Rear of a Signal

The section of track occupied by a train before it passes the signal.

In Advance of a Signal

The section of track occupied by a train that has passed the signal.

Signal Mast

A mast to which one or more signals are attached.

Signal Bridge

A structure erected over a track or tracks upon which masts and signals are located.

Bracket Post

A post with a cross piece on top on which are placed two or more masts.

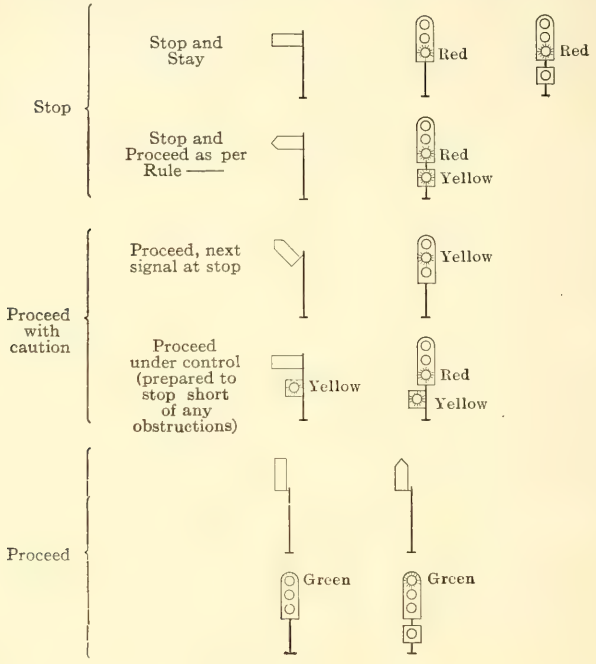
Dummy Mast

A short mast, without signals, placed on top of a bracket post to show that there is a track between the track signaled and the bracket post for which signals are not provided.

SIGNAL INDICATIONS

(For Interlocking and Automatic Block Signals, except Contactor Signals.)

STANDARD ASPECTS IN THREE-POSITION SIGNALING



The words "Stop and Proceed" shown beside the second symbol in the first column was revised to read "Stop and Proceed as per Rule .."

INTERLOCKING SIGNAL RULES

DEFINITIONS

Interlocking or Interlocking Plant

A system of switch, lock, and signal appliances so connected as to prevent conflicting signal indications and to insure the proper position of the track layout to be passed over, thus protecting train movements in interlocking territory.

Interlocking Station

A place from which an interlocking plant is operated.

Signal Operator

The person whose principal duty is to operate

(a) A fixed signal

(b) An interlocking plant.

Interlocking Signals

The fixed signals of an interlocking plant.

GENERAL RULES

1. Interlocking signal rules govern the use of interlocking signals.

2. Interlocking signals are used to govern movements over tracks where there are switches, drawbridges, railroad crossings at grade, and other conditions affecting the movement of trains.

3. Interlocking signals control the use of tracks, but unless otherwise provided, do not affect the movement of trains under the time-table or train rules nor dispense with the use or observance of other signals whenever and wherever they may be required.

4. The use of interlocking signals and the rules governing same do not affect flagging rules and none of the usual precautions are to be omitted, and flagging rules must be carried out at all times and places in the same manner as if the signals did not exist.

5. Hand signals must not be accepted as authority to pass any signal indicating *Stop* except for switching movements when the governing signal cannot be cleared. They must be given by the signal operator from the ground upon the track for which they are intended and only after the train or motor which is to make the movement has been stopped and the situation fully explained and understood.

RULES FOR TRAINMEN

10. The movement of trains will be governed by fixed signals subject to the rules.

11. A signal indicating *Stop* must not be passed except as provided by Rule ——.

12. Motormen must observe the indication of fixed signals until passing them.

13. A signal imperfectly displayed, or the absence of a signal at a place where a signal is usually shown, must be regarded as a *Stop* signal and the fact immediately reported to the .....

14. Cross-over movements in interlocking territory must be made where practicable with the current of traffic. Movements against current of traffic, outside of the home and dwarf signal limits of an interlocking plant, must not be made except under train order or flag protection.

15. When a train is stopped by a signal operated from an interlocking station, a member of the crew must report promptly at the station.

16. Conductors must report to the ..... any unusual detention at fixed signals.

17. When backing, or when cars are pushed ahead of a motor, the conductor of the train must take a conspicuous position on front of leading car, observe all signals and repeat their indication to the motorman by hand signals.

18. Interlocking signals when at *Proceed* indicate the particular route set and show that switches are locked for the train to proceed, but not that the track is unoccupied.

19. Trains or motors stopped while within the limits of an interlocking plant must not move in either direction until they have received the proper signal.

20. Trainmen must not proceed on hand signals as against interlocking signals, until they are fully informed of the situation and know that they are protected. Trainmen must not give *Proceed* hand signals which conflict with interlocking signals.

21. If a clear or caution signal after being accepted is changed to a *Stop* signal before it is reached, the stop must be made at once. Such occurrence must be reported to .....

22. Sand must not be used over movable parts of an interlocking plant.

RULES FOR SIGNAL OPERATORS

30. Signal operators report to and receive instructions from the ..... They are responsible for the safe passage of trains over the interlocking territory under their charge.

31. Signal operators will receive and obey instructions from .... concerning all questions regarding the movement of trains; and from ..... concerning all questions of care and maintenance of interlocking apparatus.

32. The normal indication of home signals is *Stop*; of distant signals is *Caution*.

33. Levers or other operating appliances must be used only by those in charge and as directed by the rules.

34. Signal operators must not make or permit any unauthorized alterations or additions to the plant nor in any way interfere with the regular sequence of operation of the apparatus.

35. Signal operators must not permit unauthorized persons to enter the interlocking station.

36. Signal levers must be kept in the position giving the *Stop* indication, except when signals are to be cleared for an immediate train movement. Signals must not be cleared until the identity of the approaching train is established.

37. If necessary to stop a train at a point at which clear signals have been displayed for it, signals must be changed to give the *Stop* indication, but locks and switches must not be changed or signals cleared for a conflicting movement until the train which had accepted the indication to proceed has stopped.

38. A switch or facing point lock must not be moved when any portion of a train or motor is standing on or closely approaching the switch or detector bar.

39. A drawbridge must not be opened until proper signals have been displayed.

40. During sleet or snow storms, special care must be used in operating switches. If the men whose duty it is to keep the switches in working order are not on hand promptly when required, the fact must be reported by wire (or telephone) to the .....

41. During cold weather, the levers must be moved as often as may be necessary to keep connections from freezing.

42. Salt must not be used on interlocked switches or other appliances except on authority of .....

43. Levers must be operated with a careful uniform movement. If the operation of a lever or other apparatus indicates a disarrangement of the parts, the signals must be restored to give the *Stop* indication and an examination made at once to ascertain if the parts are in safe and proper working order. Signal operators must see that lever is latched after lever movement has been completed.

44. Should it be impossible to lock a switch, it must be examined and spiked in proper position before train is allowed to pass.

45. When switches, signals and their connections are undergoing repairs, *Proceed* signals must not be given for movement over track sections affected by such repairs until it has been ascertained that the switches are properly set and secured.

46. Signals must not be cleared for trains to proceed except by the use of the proper controlling apparatus.

47. When a switch, movable-point frog, derail, lock, detector-bar or switch-locking circuit is inoperative, the signal operator will be given notice in writing by the maintainer and will make record of same on block sheet. The signal operator must know that each switch, frog and derail is spiked for the desired route and, when practicable, locked

with plunger, so that it cannot be withdrawn before such route is used by trains. The ..... must be notified promptly of the condition of the apparatus and the home signal governing movements over the route must indicate *Stop* and each train must be given a hand signal to proceed unless other instructions are received from the .....

48. When a switch or movable-point frog is spiked, a man must be stationed by the section foreman or maintainer to see that such parts are properly set for the route indicated by the signal operator before allowing the train to pass. The signal operator must know that switch or frog is properly set and secured for the desired route.

49. When a home signal is disconnected, it must be fastened in the *Stop* position.

50. If there is a derailment or if a switch is run through, or if any damage occurs to the track or interlocking plant, signals must be restored to give the *Stop* indication and no train or switching movement must be permitted until all parts of the interlocking plant and track liable to consequent injury have been examined and are known to be in a safe condition.

51. When a motor or train overruns a *Stop* signal, full particulars of the case must be reported at once to the .....

52. Signal operators must observe as far as practicable whether the indication of the signals corresponds with the position of the controlling apparatus and whether all signal lights are lit.

53. Signal operators must observe all passing trains and note whether they are complete and in order and markers and tail lights properly displayed. Should there be any indication of conditions endangering the train or any other train, the signal operator must take such measures for protection of trains as may be practicable.

54. Signal operators must keep proper day and night signals including torpedoes and fusees, on hand and ready for immediate use. They must keep all lights in their stations so placed that they cannot be seen from approaching trains.

55. Signal operators will be held responsible for the cars and cleanliness of the apparatus and interlocking stations while on duty.

56. Signal operators on duty must not leave the interlocking station except in case of absolute necessity, and then only when given permission by proper authority. On going off duty, signal operators must notify their relief of any special order or instructions or any defects observed in the switch or signal apparatus or any changes therein.

57. Switches must be operated upon request of signal repairmen or sectionmen whenever it is safe to do so.

58. When the interlocking fails to work properly, the signal operator will make every effort to remedy the trouble. Every precaution must be taken to avoid accident by flagging and protecting all points. Request for assistance must immediately be made upon ..... sending him full information at the same time.

AUTOMATIC BLOCK SIGNAL RULES

The following additional definition is suggested:

Track Circuit

An electric circuit, of which the rails of the track form a principal part, the means whereby the wheels of a train control the signals.

GENERAL RULES

1. Block signals control the use of blocks, but unless otherwise provided, do not affect the movement of trains under the time-table or train rules, nor dispense with the use or observance of other signals whenever and wherever they may be required.

2. The use of block signals and the rules governing same do not affect flagging rules and none of the usual precautions are to be omitted and flagging rules must be carried out at all times and places in the same manner as if the signals did not exist.

RULES FOR TRAINMEN

10. Automatic block signal rules govern the use of automatic block signals.

11. The movement of trains will be governed by fixed signals subject to the rules.

12. Where an interlocking plant is in use in automatic block signal territory, interlocking signal rules must be observed.

13. Motormen must observe the indication of fixed signals until passing them.

14. On tracks where current of traffic is in one direction, block signals govern trains running in the established direction only.

15. On single track where automatic block signals are used, if a signal indicates *Stop,* trainman must call dispatcher for orders. In case the signal is not at the time card or a train order meeting point, and trainmen are unable to communicate with dispatcher over company or other telephone lines, train after waiting .... minutes may proceed under full control after protecting rear as provided by Rule ...., and with flagman in advance a sufficient distance to insure full protection — not less than 1,500 feet.

16. On double track a train stopped by an automatic block signal may proceed after waiting one minute, provided the signal does not go to clear. Trains proceeding under such conditions must run cautiously prepared to stop within vision, expecting to find a train, open switch, broken rail, or other obstruction in the block.

17. A signal imperfectly displayed, a white light by night on any fixed signal, or the absence of a signal at a place where a signal is usually shown, must be regarded as a *Stop* signal and the fact immediately reported to the .....*

---

*Note: A local rule should be added to cover the procedure to be followed when the semaphore is at *Proceed*, but the light indication is erroneous.

18. Conductors must report to the ..... any unusual detention at fixed signals.

19. When a signal is out of order or any defect is noted in the signal apparatus, the fact must be reported immediately to the .....

20. When reporting a signal failure, the number of the signal which has failed must be given. Before reporting cause of stop as unknown, motorman must, if possible, ascertain if stop was caused by a train in in the block, an open switch or derail not in the protecting position, a broken rail or some other obstruction.

21. At switches leading to the main track in automatic block signal territory, an indicator may be provided. When it indicates *Stop*, it shows that a train is approaching or has passed the signal governing movements through the block in which the switch is located. Switch must not then be used or train allowed to foul main track. When it indicates *Proceed*, the switch may be thrown and train may move from the siding to the main track, or use cross-over switches between main tracks under flag protection.

22. When a switch indicator is apparently out of order, a train coming from a siding must protect itself as per Rule .....

23. Main track switches must be kept closed and locked and derails locked in the protecting position when not controlled from an interlocking station, unless they are to be used by a train.

24. Trains and cars on sidings must be kept clear of the fouling point.

25. A train on a siding, because of a meet with an opposing train, may pass into the block occupied by the opposing train, after the latter has made the meet and has proceeded when

(a) no other car is approaching,

(b) it is to proceed in a direction opposite to that of the opposing train.

26. After a train passes the first intermediate home signal, it must proceed to the end and out of the block before reversing its direction.

27. A train desiring to enter the main track from a siding, via a switch not equipped with a switch indicator, must be governed by the main track signals located near the switch.

28. Sand will be used on the rail within automatic block signal territory only in cases of emergency.

CONTACTOR SIGNAL RULES

DEFINITIONS

Contactor

A device usually installed on the trolley wire or third-rail, by which fixed signals are operated through contact with passing trains.

Neutral Signal

A signal showing that the block ahead is unoccupied, but which requires a change in indication before it can be passed.

Registering Signal

A permissive signal which registers and permits the passage through a block of one train or two or more trains running in the same direction at the same time.

DESCRIPTION OF SIGNALS

(Note.— The Committee recommends that a brief description of the signal system in effect on the particular road making use of the code be introduced at this point.)

LOCATION OF CONTACTORS AND SIGNALS

Contactors are usually located within or adjacent to siding limits and signals are located sufficiently in advance of contactors to permit observation of their operation while passing under contactor. Trains will be governed by the signals on the right hand side of the track unless otherwise located on account of local conditions.

SIGNAL INDICATIONS

The position, form and color of the arm displayed or the color of the disk or light as seen from an approaching train gives the indication. These signal indications and the corresponding day and night aspects for the various type signals used are as follows:

LIGHT ASPECTS IN THREE-POSITION SIGNALING FOR SINGLE TRACK, OPPOSING PROTECTION, EMPLOYING SIGNALS OPERATED BY TROLLEY CONTACT OR OTHER FORM OF END SET DEVICE.

NON-CAR REGISTERING SIGNAL

Stop: Do not pass contactor.

Proceed by contactor to operate signal.

Proceed: If Green aspect changes to Red over Yellow on passing contactor.

If Red and Yellow are displayed on approaching signal, do not pass contactor until the aspect changes to Green.

CAR REGISTTERING SIGNAL

Stop: Do not pass contactor.

Proceed by contactor to operate signal.

Proceed: If Green aspect changes to Red and Yellow on passing contactor.

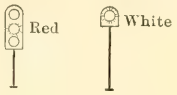
Block occupied by car running in same direction as car about to pass under contactor. Proceed by contactor and if Yellow light changes to opposite side of Red proceed under control into block.

Note: It is understood that Red with staggered Yellow on either side indicates Block Occupied with same direction of traffic and permits proceeding past contact device only; unless staggered Yellow changes from one side to the other which indicates recording of car. Changing from one Yellow to the other permits proceeding under control.

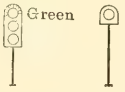
STANDARD LIGHT ASPECTS FOR CAR-SPACING SIGNALS OPERATED BY TROLLEY CONTACTORS OR OTHER FORM OF END SET DEVICE.

THREE-POSITION

Stop.



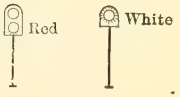
Proceed.



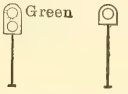
Proceed — Next signal at Stop.

TWO-POSITION

Stop.



Proceed.



Note: The aspect shown in the right hand column is a Telltale and in practice should be located on the next pole beyond the signal.

SIGNAL RULES

1. Block signals control the use of blocks, but unless otherwise provided, do not do away with the observance of time-tables or train rules, nor dispense with the use of, or the observance of other signals wherever and whenever they may be required.

2. The use of block signals and the rules governing same do not affect flagging rules, and none of the usual precautions are to be omitted, and flagging rules must be carried out at all times and places in the same manner as if the signals did not exist.

3. A signal indicating *Stop* must not be passed except as provided by the rules.

4. Motormen must observe the indication of fixed signals until passing them.

5. A signal improperly displayed, or the absence of a signal at a place where a signal is usually shown, must be regarded as a *Stop* signal, and the fact immediately reported to the .....

6. Conductors must report to the ..... any unusual detention at fixed signals. When a signal is out of order, the fact must be reported immediately to the ..... by the conductor.

7. On single track, where contactor signals are used, a signal indicating *Stop* must not be passed without train orders, or if these are not obtainable, until conductor has preceded train sufficiently in advance to stop within a safe distance any opposing trains.*

8. Trains must not be stopped with trolley resting upon contactor.

9. When approaching a signal motormen must, before passing contactor, read signal indications and be governed thereby. Where registering signals are in use, change in indication must be observed by motorman before proceeding.

10. (Restricted to non-registering type signals.) If passing under contactor fails properly to set signal upon entering a block, or to restore signal leaving a block, due to lack of power or any other cause, train must be immediately stopped, and after exchange of proper bell signals, backed-up and the operation under the contactor repeated.

EXPLANATORY NOTES

50. The block signals installed between ..... and as hereafter installed in accordance with bulletins and additions to this book, are controlled by track circuits and include all fouling sections. The particular installation above referred to is designated the T. D. B. (Traffic Direction Block) System, employing absolute blocks, that is, absolute for both opposing trains and following trains. Only one train may be in a block at one time.

The track is made a part of an electrical circuit and the wheels and axles, by short circuiting the current, enable a train to automatically protect itself.

51. Where practicable, signals are located immediately to the right of the track to be governed. Owing to local conditions, some signals are located at the left of the track to be governed and in other cases a track may intervene between the signal and the track governed.

52. The apparatus is so constructed that the failure of any part controlling a signal will cause it to indicate *Stop* and remain in that position.

53. The signal connections and operating mechanisms are so arranged that a Siding Home Signal will indicate *Stop* after a train has passed the signal, and the Intermediate Home Signal will indicate *Stop* after a train has passed a short distance in advance of the signal.

54. Each rigid switch in signaled territory is provided with a switch box and all signals leading over the switch will indicate *Stop* when the switch is open or when the switch is not set in normal position.

55. All automatic signals are distinguished by numbers indicating approximately the mile and tenths from ..... Even numbered signals govern ..... bound trains and odd numbered signals .....bound trains.

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* Note: No mention is made regarding numbering signals, as this should be covered by local rules. A local rule should also be added defining method of using signal numbers in reporting defective signals, etc.

56. Back lights are provided on the semaphore signals to give information at night regarding the position of the semaphore signal arm and are not to be regarded as signal indications. A purple light is displayed when the arm is horizontal and a white light when the arm is inclined.

Plans of the typical arrangement of signal for two opposing blocks, showing the signal indications resulting from trains in the blocks and the limits of control of each signal; also plans of the signal layout between ..... showing signaled territory, dead sections and all signals with controlling limits will be found in the back of this book. Plans of future installations will appear in bulletins regarding new signaling.

LIGHT SIGNALS FOR INTERURBAN RAILWAYS

This subject while discussed in a general way in previous reports (see 1911 Proceedings, Engineering Association, pages 235–237; Transportation and Traffic Association, pages 268–270) and in the section concerning signal installations was not considered by itself, until last year, when your Committee in its report outlined briefly the history of light signals as used by electric railways, and also made recommendations for good practice and further recommended that this subject should receive more attention by this year's Committee (see 1914 Proceedings, Engineering Association, p. 177; Transportation and Traffic Association, p. 203).

Your Committee has this year reviewed the entire subject of light signals and finds that great developments have been made in this particular phase of the art and that a careful study has been given to obtaining an increased range of vision at the same or less current consumption than formerly required.

One development is an arrangement of two lenses, the inner being the colored one which is of short focus and smaller than the outer lens, which is of clear glass. Signals furnished during the year have been made with this inner lens of 5⅜ in. diameter, the outer lens being 8⅜ in. diameter. The lenses are mounted approximately 1½ in. apart, and a concentrated double filament lamp of about twenty-five watt consumption is used. This has affected an increased range of at least 33 per cent. maintaining the same spread of light with less than half the power formerly required.

Another development is the use of a special compound toric lens using a reflector back of a concentrated filament lamp, the reflector being so placed that phantom indications are impossible. With this arrangement lenses of 8⅜ in. and 10½ in. diameter have been tried, the lens being designed in some cases to throw a narrow beam of light which can easily be seen in the day-time at a distance of from 3500 to 4000 ft. It should be understood that with this last mentioned design but one lens is used, the increase to 10½ in. being tried on an electrified steam road where long range indications were thought

desirable. In some cases one twenty-five watt lamp has been used with this design while in other cases two have been used.

A more radical departure than either of these mentioned above has been the perfecting of a light signal giving indications by the position of a beam of white light, both by day and by night. The beam is really made up of four separate lights spaced about eighteen inches from center to center, the lights being ranged in rows so as to represent a signal blade in its three positions. These individual lights are fitted with a 5⅜ in. diameter special inverted toric lens having a 12-volt, five watt concentrated filament Tungsten lamp behind it. The filament is about one-quarter inch long, and is placed horizontally and at right angles to the optical axis. In order to get a short range indication a glass mirror reflector is mounted above the lamp so as to cast a downward ray through the toric lens. The fact that there is no color to intercept the light from this signal makes it possible for the indication to be seen from 3,000 to 4,000 ft. in daylight.

All of the above mentioned types of signals have been developed and installed on electrified steam and inter-urban lines during the past year, and it is the opinion of your committee that in view of the progress being so rapidly made, that the recommendations made last year should remain unchanged pending the time when some definite standard can be adopted.

STUDY OF BLOCK SIGNAL OPERATION

Your committee was instructed to make a Study of Signal Systems on Roads, that were signaled from end to end, such study to cover maintenance cost, efficiency of operation and effect on traffic.

In January 1915, a Data Sheet, No. 126 was sent out by our Secretary to a selected list of companies with a view to obtaining information along the lines suggested for investigation. Your committee contemplated making a study of maintenance cost, efficiency of operation and effect on traffic of signal installations, for both track circuit and trolley contact signals, but the data received in regard to the latter was so meager that it could not be considered. However, the replies to track circuit signaling were much more complete and a summary of the data together with the Data Sheet is presented in Appendix **B** for your consideration.

This study of signal systems has emphasized to your Committee the lack of uniformity among different companies in the way in which signal operating data is reported. This lead to the suggestion that a Data Sheet be prepared which might be filled out by the different companies and in this way your Committee might next year obtain the information desired. Such a data sheet was prepared but it was found to be clumsy in form and failed to accomplish what was desired. It was then suggested that a Signal Report Form be drafted, with the idea of having it adopted as standard and have all companies keep their signal data in accordance with this form so that little or no

False proceed — Red
False stop — Black
False caution — Green
Cause enclosed in circle

AMERICAN ELECTRIC RAILROAD CO

Monthly Summary of Signal Performances

YEAR	Creditable stops	Track department: Poor track condition	Track department: Track switches	Track department: Track burned	Track department: Miscellaneous	Transportation department: Poor operation	Transportation department: Car off track	Transportation department: Miscellaneous	Return circuit: Bonding	Return circuit: Miscellaneous	Power department: Power interruptions at source	Power department: Oil switchout-S. S.	Power department: Fuse blown S. S.	Power department: Miscellaneous	Line department: Signal line	Line department: Power line H. T.	Line department: Trolley trouble	Line department: Foreign lines	Line department: Miscellaneous	Signal department: High track voltage	Signal department: Lights out	Signal department: Lightning arrester	Signal department: Mechanisms	Signal department: Transformers	Signal department: Poor contacts	Signal department: Switchboxes	Signal department: Maintainer	Signal department: Unknown	Signal department: Miscellaneous	Unavoidable: H. T. fuses	Unavoidable: L. T. fuses	Unavoidable: Lightning	Unavoidable: Elements	Unavoidable: Miscellaneous	Defective material: Relays	Defective material: Transformers	Defective material: Mechanisms	Defective material: Resistance	Defective material: Lightning arrester	Defective material: Poor insulation	Defective material: Miscellaneous	Number of signals in service	Number of signal movements	Number of false proceed indications	Number of false stop indications	Number of false caution indications	Total number of failure indications	Signal movements per false proceed	Signal movements per false stop	Signal movements per false caution	Signal movements per false indication	Number of cases for interruptions	Signal movements per cause
January																																																		
February																																																	
March																																																	
April																																																	
May																																																	
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July																																																	
August																																																	
September																																																	
October																																																	
November																																																	
December																																																	

False proceed — Either a "clear" or "caution" indication when a stop indication should have been given or a "clear" indication when a "caution" indication should have been given
False stop — A "stop" indication when either a "clear" or "caution" indication should have been given
False caution — A "caution" indication when a "clear" indication should have been given
NOTE A "caution" signal resulting from a governing signal in advance being "false stop" will not be reported as a "false caution"

confusion would result in the interpretation of requests for information from succeeding Committees.

A form has therefore been prepared and your Committee suggests that Member Companies give it a year's trial so that the ensuing Committee can profit by their criticisms and suggestions. In this way only can comparative operating data be obtained for the use of future committees.

REVIEW OF EXISTING STANDARDS AND RECOMMENDATIONS

Your Committee has reviewed all of the existing Standards and Recommendations in the Engineering Manual originating with this Committee in previous years and finds that there is but one change to be made, in which is Sec. Ss 5a, Standard Light Aspects in Three-Position Signaling, Employing Signals operated by Contactors.

The changes recommended are in accordance with the action taken at the 1914 Convention when in the discussion of the Contactor Signal Rules it was voted to change the wording of rules referring to Car Counting and Non-Car Counting Signals to read Car Registering and Non-Car Registering Signals respectively (see 1914 Proceedings, Engineering Association, p. 247; Transportation and Traffic Association, p. 273).

Your Committee therefore recommends that the words Car Counting and Non-Car Counting be changed to read Car Registering and Non-car Registering respectively in the Standard Aspects for Contactor Signals shown in our Engineering Manual under Sec. Ss 5a.*

A. I. E. E. STANDARDIZATION RULES

Your Committee, through a sub-committee composed of Messrs. Morrison and Waldron, considered such of the rules that would affect block signal construction and operation and recommends that they be approved.

DEFINITION OF SIGNAL FAILURE

The Sub-committee having this subject for consideration can report progress only, as it was found that there appeared to be a wide divergence of opinion as to what constituted a signal failure. It is therefore recommended that more time be given the Committee in order that it may be able to submit a comprehensive study of the situation.

HIGHWAY CROSSING PROTECTION

Since the early days when the railroads were first ordered to erect warning signs at highway crossings by various State legislatures, there has been an amazing growth in steam and electric railway and highway traffic.

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* Note: Since these aspects are shown in the Block Signal Rules, page 176 as corrected, they are not again reproduced. These changes have been formally approved by the Committee on Standards and the 1915 Convention.

Before this growth occurred the degree of personal alertness required to avoid hazards was far less than that which is now necessary. Probably the most important element, in the recent increase of attention given to the highway crossing situation, is the automobile. But happily the widespread safety first movement has, within the last year or two, done much to bring reckless and unthinking automobile drivers to a realization of the responsibilities centered in them when operating motor vehicles across steam and electric railway tracks. There is however still much to be desired.

At certain locations where highways cross steam and electric railways, protection of some sort may be desired. The form of protection may be either grade separation, gates or alarms, depending upon the comparative density of traffic and the surrounding local hazards. That the problem of properly protecting crossings, to meet traffic conditions and yet keep within the resources of a company, is a big and ever present one, is fully recognized by the electric railways. Several states have considered or passed requirements, particularly with regard to the installing of gates or alarms at intersections between tracks and state aid highways.

Laws have already been passed in the states of New Jersey and Pennsylvania requiring the steam and electric railways to install crossing alarms at every intersection with a state aid highway. In Canada, the railway commissioners have authority to draw on a fund of $200,000 a year for the abolition or the relief of grade crossing hazards.

During the five years that this fund has been in existence, 363 orders have been made, of which, 161 have been for bells, 68 for gates, 60 for subways and bridges, 14 for highway diversion and two for highway closing.

On October 4th, 1913, the Governor of Illinois held an executive conference with officers of steam and electric railways of Illinois, with a view to arriving at some plan of coöperation, with the state authorities and the county and township officials, in trying to minimize the hazards at highway grade crossings.

Steam Railway Methods and Experiences

In an attempt to reduce the number of crossing accidents, and secure better coöperation, the Chicago and Northwestern Railway Safety Committees have frequently issued printed and illustrated bulletins setting forth the most frequently happening accidents. This Company is now erecting, at all dangerous and obscure highway crossings, about 400 ft. from the track, additional crossing signs showing practically the same wording as the sign at the crossing but located in such a way as to give an advance warning. The Safety Bulletin of the Company requests suggestions from employes as to crossings at which such signs should be erected.

The Southern Pacific Sytem has been making strenuous and consistent efforts to educate the public to exercise care at crossings. In the fall of 1913, a large number of observation tests, in widely separated localities, were made by employes of the company stationed at crossings for that purpose. Then a campaign of publicity was started in every town traversed by the line and in this campaign the figures obtained, by the test, were employed to excellent advantage. Placards entitled, "Appeal For Assistance" were placed on the railroad property and distributed to garages, and summer resorts, and hung in various business centers. Other literature of the warning sort was distributed very thoroughly. The railroad employes were requested to watch for careless automobile and motorcycle drivers and report instances of carelessness, together with license numbers, to their superintendents.

Superintendents had been provided with copies of the state automobile registration lists and took up the individual cases of carelessness with telling effect. Hundreds of individual letters were written and almost without exception, it is stated, a cordial and generous response was made by the automobile owner. The campaign was even carried into the schools by division officials.

Then to determine just what effect this campaign had had, observation checks were made, at the same crossings, eight months after the original tests were made. In the first check 28,211 tests were made while in the second 89,072 tests were made. In the first check but 34 per cent of the pedestrians and drivers looked in both directions before crossing the track, while in the second check, after the publicity campaign, 60 per cent looked in both directions, an improvement of 26 per cent.

In the first check 6 per cent kept moving and looked one way only while in the second check, this was increased to 12 per cent. Or to put it another way, 59 per cent kept moving and looked neither way before the publicity campaign as compared with 27 per cent after the campaign had been in existence eight months.

Table I shows the result of the observation made by the Southern Pacific Railway at widely scattered points in Nevada, California and Oregon.

Tests, made by the Illinois Central Railroad, show that over 75 per cent of the people, passing over crossings at congested points, pay little or no attention to the approach of trains. In this connection the chairman of the General Safety Committee of the Illinois Central, states that he believes a great many people depend on their hearing rather than on their eye-sight to detect the approach of trains.

Investigations, made by the Pennsylvania Railroad and by the New York Central Lines, show that about five per cent of the persons using the crossings, stop, look and listen.

Investigation, made by the Baltimore & Ohio, covering nearly 30,000 observations, resulted in the following:

9.0 per cent stopped and looked in both directions.
14.9 per cent kept moving and looked in both directions.
26.9 per cent kept moving and looked one way only.
57.3 per cent kept moving and looked straight ahead.

Comparing these with the observations of the Southern Pacific, before that road's campaign of publicity, we find that almost exactly the same percentages hold for those who stopped and looked in both directions (one per cent) and those who kept moving and looked straight ahead (58 per cent approximately).

TABLE I — SUMMARY OF OBSERVATIONS MADE BY SOUTHERN PACIFIC RAILROAD CO.

Item	Automobiles				Teams				Pedestrians				Total			
	1913		1914		1913		1914		1913		1914		1913		1914	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Stopped and looked in both directions	35	1	139	1	.....	..	.....	..	.....	..	.....	..	35	1	139	1
Kept moving and looked in both directions	4,734	28	8,401	51	2,546	52	9,171	52	2,268	36	35,569	65	9,558	34	53,141	60
Kept moving and looked one way only	416	2	2,255	14	417	8	2,595	14	951	15	5,680	10	1,784	6	10,530	12
Kept moving and looked neither way	11,836	70	5,686	35	1,926	40	5,989	34	3,082	49	13,586	25	16,844	59	23,261	27
Ran over crossing at reckless rate of speed	3,301	19	446	3	.....	..	.....	..	.....	..	.....	..	.....	..	446	...
Grand total	17,021	..	16,482	..	4,889	..	17,755	..	6,301	..	54,835	..	28,211	..	89,072	...

It should be remembered that after the Southern Pacific educational campaign, this latter percentage was reduced to 27 per cent, that is, half of the people, who formerly paid no attention to the condition of the track, now stopped, looked or listened.

The foregoing statements and figures show the value of educational work on the public and directly shifts a larger part of the responsibility to the public.

Protective Methods

In order to set forth clearly the protective methods that may be followed in an endeavor to make a crossing more safe, for the passage of trains and highway traffic, your attention is called to the following statement of fundamentals:

Kinds of Protection

A. Improvement of physical conditions surrounding crossings.
   (1) Grade separation.
   (2) Re-alignment of highway. This to give better vision, reduce length of time vehicle is on the crossing and decrease installation and maintenance cost.
   (3) Removing obstructions to view of approaching trains, such as hedges, brush, trees, buildings, fences, bill boards and embankments.
   (4) Improvement of highway profile.

B. Installation of protective apparatus.
   (1) Barriers, (a) gates, (b) watchmen.
   (2) Signals, *i. e.*, signs and alarms.

The protective methods for improving the physical conditions surrounding crossings are so well known and recognized that attention will here be given to the subject of crossing alarms and barriers.

Highway Crossing Signals

An editorial, in the *Electric Railway Journal* of July 11, 1914, presented some of the fundamentals controlling the choice and installation of highway crossing protection systems.

Highway crossing signals perform two functions. They designate the location of crossings and they announce the approach of trains to the crossings.

Probably the simplest form of signal, for informing the traveler on the highway that he is approaching a railroad intersection. is the old-fashioned "Stop, Look, Listen" signboard. Somewhat similar boards are now being used as distance signals for crossing bells, as already mentioned.

The second function of the highway crossing signal, that of announcing an oncoming train, is more difficult of performance. Various means have been employed more or less successfully. Among the more common types now available for installation on electric railways are the simple illuminated crossing sign the intermittently illuminated

sign, which gives repeated flashes of light, the signal with moving parts imitating the waving or swinging of a red blade or flag, and various combinations of these aspects, all designed to be arrestive. Combined with these visible indications are audible indications such as bells, gongs and sirens.

The prime requisite in a highway crossing signal is reliability and unless a signal is reliable it will not command the respect of the frequent traveler, as it may even introduce a hazard from this cause. A highway crossing signal should be so controlled that the train, by passing certain limits or being within a certain section, will cause itself to be announced at the crossing. There are two forms of control, intermittent and continuous.

With the intermittent control the electrical signal release is actuated, either by the passage of the car wheels or the trolley wheel past some setting device. The car-wheel type of control may be the old-style steam railroad track instrument, a short insulated track section or a contact bar, placed adjacent to the rail and so located that the flange or tread of the wheel will touch it. Another type successfully used is that in which the control is obtained by the movement of the rail. This movement, in one make of signals, is mechanically multiplied and drives a small generator which supplies an electrical impulse to release the bell. In another kind the movement of the rails opens or closes balanced contacts attached to the base or side of the rail.

By each of the foregoing intermittent-control devices the highway crossing signal is started and stopped by the passage of any car, whether it is a motor car or not.

The second, and very common form of intermittent control (trolley contactor type), is obtained by a trolley wheel passing along the wire, the wheel either mechanically throwing a switch or electrically making a desired contact. Contrasted with these intermittent forms of control is the continuous control obtained with track circuits to which are connected interlocking relays that in turn energize the crossing bells and lamps whenever a car is passing through or standing within the block.

A feature of importance which should be recognized in the design of highway crossing protective apparatus, in addition to reliability, is that of continuity of signaling. As, for example, if more than one train should enter the ringing limits at one time and later, one should pass out, or both stop for sometime and then proceed across the highway, the signal must warn against the last as well as the first car crossing.

Thus car-counting devices are an important feature in the intermittent scheme of control. It is important to so arrange the device that, if several cars are near the crossing simultaneously, the bell will keep ringing as long as there is one car inside of the control zone. The continuous track circuit performs this function in the ideal way, but is little used on an electric railway because of its high first-cost. With trolley-contact control and with mechanical rail contact the

desirable feature, just mentioned, may be approached by placing extra contactors or restarters between the first starter and the crossing. When trains, entering the protected zone, do not proceed directly over the crossing, devices have been installed so that the bell will stop ringing after a predetermined time. An additional instrument or contact insures that, in a case of this kind, warning will be given when the train again proceeds. The use of this feature makes possible the use of bells near residences, where they might otherwise be objectionable.

Types and Costs of Crossing Alarms

Inasmuch as there is such a wide variety of crossing alarms, all available for use on electric railways, some brief descriptions of the various types will be presented. Space and time limit the descriptions to chief characteristics of each type mentioned, the principle features being the method of control, the kind of indication given and the method of giving the indication.

The manufacturers, who have supplied the Committee with information about their crossing signals designed for and now in use on electric railways, are:

The L. S. Brach Supply Company.
Hoeschen Manufacturing Company.
Protective Signal Manufacturing Company.
United States Electric Signal Company.
Nachod Signal Company, Inc.
Railway Specialties Company.
Automatic Signal and Appliance Company.
Electric Service Supplies Co.
National Electrical Mnfg. Co.

Other companies which have electric railway crossing signals in process of development but not yet installed in actual service are:

The Union Switch & Signal Company.
Chicago Railway Signal & Supply Company.
Bryant Zinc Company.
The Railroad Supply Company.
The Handlon-Buck Company.

Descriptions of Crossing Signals

Some of the crossing signals, now installed on electric railways, will be described briefly.

Brach Automatic Flag Man

This signal combines visual and audible indication. The visual indication employs a moving red light to convey the impression of danger by representing a swinging red lantern. A locomotive bell is used, the loudness being adjustable. The signal or light effect is accomplished by moving a brush over a commutator furnishing energy

to eight lamps, which are mounted in the form of an arc. They are lighted successively backward and forward. These lamps are located between lenses which face both ways from the track.

The lamps are plainly visible in the daytime. This signal has no parts exposed to the weather. A small motor is employed to operate the commutator and ring the bell. For the control, either a type of rail or trolley contact is used. A time element cut-out may be used if desired, also a car-counting device. The time element permits a train to stop within the control limits without having the bell ringing continuously, and the counter allows one train to follow another closely over the crossing, both operating the signal.

Hoeschen Magneto Mechanical Signal

The Hoeschen signal is actuated by a powerful spring motor. The motor is wound by the natural movement of the track rail, which is transmitted to the winding mechanism of the motor by means of a connecting rod and plunger lever resting against the base of the rail.

The starting apparatus is not in any way connected with the trolley or transmission circuit, this particular feature being considered as one of the chief advantages. The small electric impulse necessary to unlatch the bell, when a car passes the control point, is generated in a piece of apparatus also connected with the track rail and actuated by the depression of the rail as the car passes the control point. The generator consists of a laminated permanent magnet, through the poles of which two generating coils are bolted. A keeper, placed across the faces of these two poles, is operated by a lever clamped to the base of the running rails in such a way that the rail is twisted and its gage line raised about one eighth of an inch above normal surface. When a car passes, the rail is depressed to its normal level and the lever, connected with the base of the rail, kicks the keeper away from the pole faces of the coils, which are attached to the permanent magnet. This breaking of the magnetic circuit generates an electrical impulse which is sufficient to unlatch the bell-ringing, spring-actuated motor. The passage of the car, by the crossing bell and the automatic winding due to the depression of the rail at the bell, cut out the ringing mechanism.

Some of the features emphasized as of particular value to electric roads are that no battery or trolley of high-tension connection is necessary, and that neither the rail bonding nor the block signal track circuits are interfered with. As the car itself actuates the control, the bell will operate equally well whether or not the train is motor or engine-drawn or whether or not the trolley is on the wire.

The indications available include swinging bell, an illuminated sign reading "Danger", and a set of red and white semaphore blades which wave through an arc. The Illinois Traction System has recently installed, at Champaign, Illinois, a so-called silent crossing signal equipped

with two oscillating blades and a flashing red danger sign four feet long. This signal, with others of the same type to be installed, is placed within the city limits where the noise, from a loud bell, might be objectionable. Diagonally across the tracks, there is an illuminated sign reading "Railroad Crossing"; the word "Danger" being shown in red when a train is approaching.

Protective Signal Manufacturing Company

The feature of this Company's crossing signal is the form of oscillator control. This oscillator acts on the push-button principle in opening or closing the control circuit, which, in turn, actuates a relay that energizes the bell, lights and display features.

The oscillator is a horizontal weight vibrating member with a contact point at its free end. This member and its adjustments are enclosed in a waterproof iron box that is clamped to the base of the track rail at the control point. The oscillator is connected to the line through a waterproof conduit in which the leads are encased. It is in series with a source of energy of low voltage. The passage of a car over the track imparts a vibration to the rail, and starts the vibrating member moving, which, in turn, opens the control circuit within the oscillator case. This causes the line relay to drop and energize the bell or signal. The oscillator is not connected electrically with the return propulsion circuit and so may be installed and operated in the midst of interlocking or other circuits. It requires no adjustment of the track or ties. Bells are supplied with and without time elements, and any number of oscillators may be installed within the control zone to obtain restarting control. An oscillator at the signal location serves to cut out the bell when the train passes the highway. The signal is made with both audible and visual indication, as desired.

United States Electric Crossing Signal

This equipment consists of a crossing bell, with or without lights and semaphores, and three trolley contactors. One contactor is located at the crossing and one at each distant starting point. The contactors are directional in operation and the control is designed to provide for two cars passing through the control section at the same time. This crossing signal is operated by trolley current and its parts are standard with those of the United States trolley contactor block signal system. Also, provision is made for indicating to the motorman of an approaching car that the signal is operating.

Nachod Crossing Signal

This signal has trolley contactor control and is fed from the trolley circuit. Three contactors are used. These are without moving parts and the starting contactors are directional. The apparatus is standardized with that of the Nachod Automatic Block Signal System. The

control is such that cars may pass through the control zone in any manner, and so long as one remains between the starting contactor and the highway, the bell will continue to ring. The bell is mounted at the top of the case which contains the oil-immersed relay and other moving parts. The danger sign, electrically illuminated, is flashed by a make-and-break contact on the bell clapper. A motorman's indicator is provided if desired.

Railway Specialties Company's "Wigwag"

This signal is used in large numbers by the Pacific Coast electric railways, one road having installed one hundred and twelve. The signal may be mounted either on a post or on a cantilever bracket projecting from a post. The signal itself consists of a disk 26 in. in diameter and painted red. Upon it is the legend, "Stop, Lookout." At the center is a red bullseye lens illuminated with an electric lamp. Attached to the mechanism case is a 12 in. gong.

When in operation the red disk is waved back and forth through an angle approximately 60 deg. and at the rate of 72 strokes a minute, i. e., 36 each way. At the same time the bullseye lens is illuminated, and at night time presents a waving red light in place of the disk. While the flag and the light are in motion the gong is sounded at the same rate as the rate of oscillation of the disk. The gong, however, can be cut out if so desired.

For electric operation the open circuit is employed, a contactor being placed at any desired distance on the trolley wire or on the third rail, which diverts current to a high-voltage relay at the signal, thereby cutting in the power from the main conductor to the mechanism. A similar contactor placed at the crossing, and connected to the opposite side of the relay, opens the circuit as the train passes the crossing.

"The Automatic" Crossing Bell

This crossing bell is operated by trolley current and is controlled by an insulated track circuit, one rail only being insulated, leaving the other rail for the return trolley current. The length of the insulated rail is determined by the speed of cars at the crossing to be signaled, but usually extends from 900 to 1500 ft. in the direction of traffic. The rail section terminates at the crossing.

On single track an interlocking relay is used so the bell rings only when cars approach the crossing. A dry battery is used to operate the track circuit in connection with a small track relay, thus assuring the continual ringing of the bell while one or more cars occupy the insulated rail. When a visual signal is desired a lighthouse type of illumination is provided by mounting lamps in front of reflectors and revolving a pair of such lamps on a vertical shaft driven by a small motor.

Other Types

The Electric Service Supply Co. state they are redesigning their outfit and therefore cannot give data at this time.

The National Electric Mnfg. Co. did not reply to our request for information.

TYPES AND COSTS OF GATES AND WATCHMEN

Distinctive from the methods of protection, already described, are those of crossing gates and watchmen. Both of these methods have undoubtedly been used for a longer period than any of those already mentioned, and yet the development and recent large use of the crossing signal would seem to indicate that these older practices left some want unfilled, that was desirable.

The use of and incompleteness of protection afforded by a watchman waving a flag on the crossing is too well-known to require much explanation. Watchmen were, almost without exception, men old in the company's employ, who had outlived their usefulness elsewhere, quite often aged to the point of feebleness or else crippled, the service given by them was incomplete and undependable. At the same time the costs were excessive, these varying from $25 per month for a single shift crossing, protected only during the daytime, to from $50 to $75 or $80 per month for crossings requiring protection during the 24 hours.

Crossing gates have a place which cannot be filled by any form of warning signal alone, their use is however mostly confined to busy street crossings, in or adjacent to towns or villages, or to main thoroughfares in the thickly settled suburban districts. They are expensive to install and maintain and until very recently required, without exception, attendants to operate them if satisfactory service was to be derived from their use. While automatic gates have been on the market for some time, they have been little used, the danger of a gate of this character, dropping on or trapping a vehicle on the crossing between the gates being considered too great to allow their general adoption.

The chief disadvantage of the gate, however, has been its cost, which has absolutely precluded its use for such crossings as the average interurban desires to protect.

Manually controlled gates are divided into four classes, namely: Mechancial; Pneumatic; Electric and Wire Connected, the latter being, in a general way, included under the first sub-division, Mechanical Gates.

Mechanical Crossing Gates

The designs, for mechanical operation, are known as lever and crank gates. In the lever type, the operator may be located in a tower or on the street level. The crank type requires the operator to stand at one of the gate posts. Connections between gates in both types are similar. Motion is transmitted from the main sheave of the gate post, through a chain to a horizontal steel rod, run through a pipe. This pipe is

carried underground to either the opposite gate or operating lever stand. The main, or street arm casting is provided with counterweights in the form of flat round disks, which vary in weight from ten to 40 lb., each post averaging about 60 lb. The street arms are provided with a hook for a lantern by night, which lantern is replaced by a small weight by day. The sidewalk arm is operated by means of a gear in the casting which meshes with a gear on the street arm casting. When the gate is in the "down" position it is locked by means of a latch on the lever. It is also good practice to provide a notch in the lever stand to lock the gates in the "open" or clear position.

Foundations, for gate post castings, are usually framed of timber but recently have been replaced by a more expensive and more durable concrete construction. Care must be taken to insure a level post and good alignment. A slight elevation of pipes toward the center of the street insures proper drainage. Wood boxing around pipe, especially in unpaved streets has proven very successful. Where timber foundations are put in, bolts should be used throughout, as lag screws work loose, invariably causing trouble.

Pneumatic Crossing Gates

The design, for pneumatic gates, are known as Diaphragm and Cylinder types. Compressed air is supplied by means of a hand pump or in some cases by means of a continuous supply from a compressor.

Diaphragm Type: Opposite gate posts are connected mechanically by means of pipe enclosed rods which are chain connected as in a mechanically operated gate. The gates are operated by the gateman in a tower. One pair of gates is so connected that the application of pressure, to the diaphragms, will raise them and through the mechanical connection, those across the track. This latter pair will be lowered when air is applied to them, they in turn lowering the pair first mentioned. The diaphragm consists of a steel bowl having a helf-inch pipe inserted on one side and a rod connected with rubber diaphragm through opposite side which is crank connected with chain which, in turn, operates gate arms.

Cylinder Type: The cylinder gates act on the same principle except the mechanical connection, between opposite arms, is replaced by an air pipe connection. Two cylinders replace the single diaphragm one for *down* movement, which, in turn, is connected with opposite gate cylinder through an equalizing cock, and one for *upward* movement connected likewise. The reason for interconnecting opposite cylinders is that less air will escape over piston heads than will escape through stuffing boxes, thus keeping constant equilibrium between opposite arms.

While installing this type it is well to take great pains with balancing the load on cylinders and distributing air pressure load equally. Drainage should be carefully considered, to avoid freeze up from condensation.

Electric Crossing Gates

The electric gate is of recent design and very few are in actual operation. The one shown is of the motor driven type. The source of supply may be either direct or alternating current. A one-quarter horse power motor, series reversible wound, is placed in each post. A heavy roller chain runs from sprocket on motor shaft to a sprocket on a worm shaft, the worm meshing with a worm gear. A forked connecting rod is fastened on a pin projecting through the worm gear, giving a central pull on the gear. The other end of the connecting rod is connected to the main arm shaft.

Attached to the commutator end of the motor shaft is a pulley, on which is an automatic magnetic brake, which stops motor instantly when current is cut off. Feed wires are run to a small switchboard in the tower from which current is fed to the gates by means of a double throw switch. When the switch is up, current goes to the motors driving the gates upward. When the street arms have raised to an angle of 70 deg., an automatic cut-off in the gate post, cuts off the current supply, magnetic brake is de-energized and the gate comes to rest, being locked in the up or clear position. Should the operator, for any reason, desire to stop or reverse the movement of the gates, he pulls out the lever, which de-energizes the magnetic brake, the gates come to a stop and when the switch is thrown in the down position, the motor reverses and the gates go down. The automatic cut-off works in both directions, cutting off current and leaving the circuit in the position to operate the gates in opposite direction.

The automatic cut-off is located in the gate post casting and is connected with the worm gear. It consists of fibre disks with one-half inch brass rings. On these disks are contact points or brass pins, to which are connected wires in series with motor and brake. The connection to worm gear is direct on the shaft and is rigid. It travels in a half circle, causing one of the brass pins to pass off of the rings breaking the current and setting the brake. At the same time it engages another pin, with brass ring in readiness for reverse movement of switch in tower, and consequent reversal of operation of gate. All parts are enclosed in the gate post casting, protected from the weather. Access to the post, for wires, is obtained through the pipe conduit which is properly bushed. Large doors are provided, giving ample room for inspection of the working parts and any part can be withdrawn from the post, through the door, if necessary. The sidewalk arms are crank connected to the street arms so that when the street arms raise to 70 deg. the sidewalk arms are at 90 deg. The degree of the street arm may be increased to 90, but it has been found that 70 deg. is preferable on account of the gain in leverage. The length of the street arms vary from 30 to 50 ft.

Concrete foundations, with conduit inserted, are preferable for this type of gate. All lines should be properly fused to protect the apparatus.

WIRE CONNECTED CROSSING GATES.

This type of gate is especially adapted to high and dry locations, where gates are a short distance apart. The posts are of timber, set in the ground and treated well with carbolineum or other wood preservative. Cast parts are few in number and easily assembled. The main shaft is held in place by a cast iron shaft box, which is bolted to the post. Motion is transmitted in much the same manner as with the mechanical gate except that two iron wires replace the horizontal rod. The wires are run through a pipe filled with oil or graphite with stuffing boxes at either end. A chain is used for all turns. Counterweights are provided on the street arm casting, and a center stop, with coil spring, so that the gate is held in balance, and when lowered the strain is minimized

SPECIAL CASES.

On the Chicago and Oak Park Elevated Railroad, at certain points, trains are operated on the surface. The tracks parallel the elevation of the Chicago and Northwestern Railroad. On the north side is a retaining wall; on the south is a street line, which compels the gateman to operate between tracks. To give him protection, an enclosure has been built, between the tracks in the parkway, four feet high. Four posts are set in the ground and enclosed on three sides with dressed and matched lumber, making the enclosure four feet wide and six feet long. The height is just right for a view of the gateman and high enough to afford good protection from passing trains.

On the Northwestern Elevated Railroad, Chicago, Evanston Division, people continually went under the gate arms. A simple attachment or apron was added to the street and sidewalk arms. This consists of pine strips suspended parallel to the arms by means of strap iron. This makes an effective apron and adds little to the counterweights. This type of apron has been adopted as standard on all lines of the Chicago Elevated Railways. "*Safety First*" signs enameled red and white on No. 16 sheet steel are placed on outside face of all gate arms.

Where a single platform is used between the tracks on wide centers, and exit to the street comes between the tracks, an additional short arm gate is installed to keep passengers from crossing the tracks until the train has passed. This extra arm is operated by a separate lever adjacent to the gate levers and is independent of the street arms.

Cost and Operating Charges for Different Type Gates.

Type of Gate	Number of typical sets taken as criterion	Average cost of installation 4-post set	Cost of operation per year per set. (Average)	Maintenance cost per year per set. (Average)	Remarks
Mechanical.....	55	$475 00	$900 00	$30 00	(Exclusive of tower)
Pneumatic.....	319	700 00	820 00	50 00	(Exclusive of tower)
Electric.....	1	950 00	984 00	60 00	(Estimated)
Wire-operated....	1	160 00	500 00	20 00	(Estimated)

A recent development in crossing gate design is an automatic gate which does not obstruct passage over the crossing while the gate is down and which, therefore, eliminated one of the great objections to the use of the usual type of gate when automatically controlled. This device consists of an arm supported on a post located at the side of the highway, the electrically operated mechanism being housed in a case at the bottom of the post. From the arm, which extends out over the highway, a number of light chains are depended, these, when in the lowered position, reaching to within a few feet of the ground. The arm itself never descends below a height sufficient for a vehicle to drive beneath it, in this way affording any easy excess from the crossing, through the chains. In case the arm is lowered while the passing vehicle is on the crossing. It is of course necessary to install one of these devices on either side of the tracks to obtain the maximum protection.

The position of the arm is an indication as to whether or not it is safe to proceed over the crossing, the chains forming a tell-tale in case the arm is overlooked. The arm is illuminated at night by a light placed near the top of the signal post, and in addition to this indication, a bell is rung and a red light is displayed toward the highway when a train is approaching.

The method of controlling this device can be through the medium of a track circuit, track instrument, or trolley contactor.

Census of Crossing Alarms in Use by Member Companies.

In answer to data sheets sent to Member Companies requesting information as to crossing alarms in use, 112 companies stated that they had none in service, while 35 were using bells in greater or less quantities.

Of the roads using protective apparatus the largest number of signals in use on any one property was 112. The total number of signals in

use by the 35 companies is 468, or an average of over 13 to the company, and of the total number 448 were audible, 298 had visible daylight indications and 358 were visible at night.

In way of explanation, it may be said that the use of combined audible and visual indications is of more recent development than the audible alone which undoubtedly accounts for the comparatively low number of visual daylight signals. It should be also noted that some companies reporting have considered a bank of lamps burning at the crossing as visible in daylight and these are therefore included but in each case a note of the conditions is made after the entry. It should also be noted that there are 20 signals that are visual only, having no bell or other audible attachment; this is undoubtedly accounted for by the signal being installed in a thickly settled neighborhood or close to some church or school where the noise of a bell would be objectionable.

The method of controlling the various signals is as follows: a.c. track circuit 14; d.c. track circuit 4; short insulated section 2; track instrument 239; third-rail and trolley contacts 194; the replies sent in as to the remaining 15 were such that the system could not be definitely fixed.

Two hundred and ten signals had time limit devices, undoubtedly others were also so equipped but the replies did not indicate, but those roads having the majority of installations without this feature, answered that it was desirable, in fact only three roads stated that the time limit was not a desirable attachment.

EXPERIENCE AS TO TROUBLE OCCURRING AND SUGGESTED IMPROVEMENTS.

In replying to the questions as to failures and their causes almost all of the companies have two or three items that seemed to be giving them most of their trouble and by referring to the data sheet valuable information can be obtained on this which should be of considerable benefit in purchasing new signals.

As to improvements suggested: The one most frequently mentioned was the need of a pilot light for the motorman of an approaching train, so that he would know if the signal was properly operating. The bettering of this indication, as now provided on several signals, was also thought desirable. A signal which would show a green light towards the highway when no train was approaching, and a *stop* or *danger* indication when the signal was out of order was also included. All of these points may be of considerable value not only to the railroad companies but also to the manufacturers.

It was found that most companies were using some form of crossing sign at their crossings in addition to any other protective device installed.

INSTALLATION, MAINTENANCE AND OPERATION COSTS.

As to the Installation, Maintenance and Operating Methods and Costs, an attempt was made to gather some definite data on these subjects and as is usual in a case of this kind, figures differed widely, due undoubtedly to varying local conditions that do not appear in the replies.

The figures for installing a single track warning signal, exclusive of the cost of the signal equipment itself, varied from $25 to $400, the average being $151. For a double track installation the cost figures varied from $55 to $450, the average being $152. It is therefore evident, considering all replies, that the double track installation costs very little more than one on single track.

As to the number of signals which could be maintained by one man this figure varied from 15 to 100, the average being about 46. Undoubtedly this wide difference can be partially accounted for by the fact that some roads combine crossing signal maintenance with other signal and telephone work, while others have men for their crossing signals alone. Information as to this will be found on the data sheet.

The actual maintenance costs vary as widely as the installation costs; one road, having a total of 29 signals, maintained them at a monthly cost of $0.65 per bell per month, this data being collected over a year's operation. Another road having 64 signals reported their cost as $2.86 per signal per month. Some roads report as high as $5 per signal per month. Sufficient data was not at hand to reduce this cost to the basis of a single movement, as in a number of cases the movements per month were not given, but undoubtedly this item would directly affect the maintenance. Of the two roads mentioned above, the first, with the less cost for upkeep, had a little less than one-third the number of operations than the road whose maintenance cost $2.86; and using these two as a basis, the maintenance cost per operation would not differ greatly. The average cost taken from all replies received is $2.52 per bell per month.

The large difference in the above figures will be somewhat understood when the replies to another question are studied. This pertained to the frequency of required inspection. Four roads inspected daily, one three times a week, five weekly, one every two weeks and five monthly. This is undoubtedly another point governed very largely by the number of train movements past a signal, as well as by other varying conditions, thereby making a direct comparison of results as reported somewhat misleading.

The distance for placing starting devices from the crossing were much more consistent, the average being about 1,500 ft., the general idea being that from 20 to 30 sec. should elapse between the time the bell started ringing and the train reached the crossing.

Conclusions.

In conclusion your committee wishes to point out that the method of protection of highway crossings is still in the development stage and that, therefore, no definite recommendation can be made at this time. It would suggest that in future development more careful attention be given to the securing of more uniform aspects, which can only be accomplished by a close coöperation between the railroad companies and the manufacturers.

Safety at highway crossings is a condition for which the responsibility should be borne largely by the public, either through the local municipality or the state, for without public aid it is impossible for an interurban railway to maintain crossings at which accidents will not occur. Study of this subject reveals the need for more coöperation on the part of state, county and local governmental bodies. Such coöperation should make available funds for the physical improvement of crossings and also new laws should be passed which would facilitate changing or protecting highways without undue expense to the railways. The need is also urgent for more stringent laws governing the behavior of pedestrians and vehicles and particularly automobile traffic across railway tracks, relieving the railway company of liability in case of their violation.

OPERATION OF SINGLE TRACK LINES BY BLOCK SIGNALS ONLY

For high speed, heavy interurban single track operation with track protected by automatic block signals having continuous track circuits, the preponderance of evidence obtained from a large number of representative electric and steam railways indicates that the use of dispatchers and time-card rights, augmented by standard train rules, is the most approved practice.

However, development of the art may considerably change the present opinion, as in some instances short stretches of lines are now operated by signal indication only, and under the partial direction of a train dispatcher, and it is the feeling of your committee that experience may prove it feasible to operate trains by signal indication only, under the partial direction of a train dispatcher or other officer used in a supervisory capacity, and where proper protective train rules are used, provided the railway is equipped with modern automatic signals whose electrical circuits are free from outside interference.

Form of Contract for Signal Installations

In addition to the subjects assigned by the Executive Committee your committee thought it advisable to give attention to the information necessary to give to signal manufacturers when wishing to receive estimates for new construction and a sub-committee consisting of Messrs. Leisenring and G. N. Brown was appointed to consider this question.

They can submit only a progress report as it is felt that this subject is worthy of another year's study. However, it is recognized that an estimate data sheet for a-c track circuit signaling is needed and there is appended to this report as Appendix **D** such a sheet.

This is submitted for criticism and suggestion and your committee asks that it be given careful consideration.

Respectfully submitted,

C. H. Morrison,
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H. A. Nicholl,
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Joint Committee on Block Signals for Electric Railways.

APPENDIX A

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(Supplementary to that made by 1914 Committee)

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Sundry

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A. R. A. Report. In *Railway Age Gazette* (*July 10, 17* and *24, 1914*) 57:2:42; 57:3:89; 57:4:151.

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(Editorial). In *Electric Railway Journal* (*August 1, 1914*) 44:5:197.
Discussion. In *Electric Railway Journal* (*August 15, 1914*) 44:7:305. By W. R. W. Griffin, Edward Dana, L. H. Palmer; (*September 12, 1914*) 44:11:484. By John Leisenring; (*October 3, 1914*) 44:14:618. By F. A. Boutelle.

Protection by Flag in Advance (Editorial). In *Electric Railway Journal* (*November 21, 1914*) 44:21:1128.

Protection by Flag on Slow-Speed Lines (Editorial). In *Electric Railway Journal* (*August 8, 1914*) 44:6:241.

Revival of the Flagging Rule (Editorial). In *Electric Railway Journal* (*September 12, 1914*) 44:11:467; (*October 3, 1914*) 44:14:599; (*November 21, 1914*) 44:21:1165, discussion by John Leisenring; (*November 14, 1914*) 44:20:1100, discussion by C. F. Handshy.

Scranton & Binghamton Railroad. A New Method of Acceleration on. In *Electric Railway Journal* (*October 3, 1914*) 44:14:602.

Signal Lights and Line Voltage (Editorial). In *Electric Railway Journal* (*August 22, 1914*) 44:8:331.

Tests, Interlocking Plant. By W. F. Price and D. K. Crawford. In *Signal Engineer* (*April, 1915*) 8:4:111.

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Traffic Control, Illuminated Signals for, at Cleveland. In *Electric* In *Electric Railway Journal* (*October 3, 1914*) 44:14:630.

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Signal Installations Subsequent to 1914 Report

The Committee heretofore in its report has given over an Appendix to the description and illustration of various installations, but this year the space devoted to this phase of the subject has been materially cut down and only an abstract of the important installations is here produced.

AUTOMATIC BLOCK SIGNALING INSTALLED BY THE UNION SWITCH & SIGNAL COMPANY BETWEEN JULY, 1914, AND JULY, 1915, ON INTERURBAN ELECTRIC RAILWAYS.

This company has, up to July 15, 1915, furnished material for and installed automatic block signaling on seven interurban railways, four of which are initial installations and three are on roads previously signaled.

A summary of this signaling, including mileage of protected track and the number of signals, but *exclusive* of any signaling on electrified steam roads or heavy urban electric lines is given herewith.

This company reports new features in interurban signaling as follows:

A new lower cost light signal termed "Model 15" having 5 in. lenses and a maximum range of about 1000 ft. under the most severe sunlight conditions. This signal is provided with the artificial background, hood and adjustment for horizontal and vertical curvature, as used on their longer range signals.

A new relay termed "Model 15" combining vane design and polyphase principles, thereby securing simplicity and economy of power. It can be employed in single or double track work as a two-position track relay, and in double track with three-position signals as a three-position track relay. As a line relay it can be used as two- or three-position on single or double track work.

A new switch indicator employing an electric lamp instead of a semaphore, this reducing the cost and amount of apparatus. A push button used in connection with this indicator keeps the lamp normally unlighted and gives the indication only when the trainmen desire same.

All of the signal installations herein reported include continuous alternating current track circuits, which allow both rails to be used for propulsion purposes, the control of signals by all switches and the protection of movements into and out of sidings.

Brief descriptions, including the interesting features of the installations covered by the summary, are given below:

SCRANTON & BINGHAMTON RAILROAD

(Lake Winola Line)

(Nicholson Line)

This single track signaling of twelve miles covers six miles of main line and six miles of branch line, the latter leading to a summer resort known as Lake Winola. The traffic is very heavy on the Lake Winola Line in summer, whereas the winter traffic is very light on this line and heavy on the Nicholson Line.

The installation on these two lines is an extension of the ten miles of signaling reported last year, and includes eight blocks of four signals each.

The T. D. B. system with direction indicators, 2-position Style "B" bottom post mechanism semaphore signals for sidings, and Model 13

light signals intermediate to sidings, proved sufficiently satisfactory on the first installation to be used on this second one without change.

This road has been operating now for over one year by automatic track circuit signals only, and has found the operation highly satisfactory.

A number of intermediate switches in this territory are protected by switch indicators employing manual time release, as a similar arrangement in the first installation proved to be suitable for controlling such movements.

INDIANA RAILWAY & LIGHT COMPANY

(Junction to Pitt, Indiana)

This installation of eight signals protects 7.1 miles of single track by two siding to siding blocks.

The traffic is limited passenger, local passenger and freight. The T. D. B. system, with Model 13 light signals and switch indicators of the semaphore type, is used throughout.

DETROIT, MONROE & TOLEDO SHORT LINE

(Rockwood, Michigan)

This installation covers a special arrangement for the protection of a gauntlet on double track and a crossover in the immediate vicinity.

The signals are of the two-position Style "B" bottom post mechanism semaphore type, and the switch indicators are of the semaphore type.

MICHIGAN UNITED TRACTION COMPANY

(Corinth Hills, Michigan)

This is a 2400 volt road between Grand Rapids and Kalamazoo, and the signaling herein referred to protects a series of bad curves between two passing sidings three miles apart.

This installation is the first employing three-position signals in connection with the T. D. B. system (single track) and, further, on account of very high speed (up to 70 m.p.h.) employs preliminaries beyond the sidings for control of the 90 degree position. All signals are of the Style "B" bottom post mechanism type and the one indicator used in this layout is of the light type.

THE RHODE ISLAND COMPANY

(Buttonwoods-Rocky Point Line)

The Rhode Island Company operate a very frequent service from Providence to an amusement resort on Narragansett Bay known as Rocky Point in the summer time, as well as serving a number of shore resorts between Rocky Point and the city. A portion of the line signaled leads to a point known as Buttonwoods, where connection is made with another line leading into the city of Providence. The

service at times amounts to 75 seconds headway when the speed is low, but at other times, when the headway is greater, the speed becomes 35 m.p.h. The territory signaled includes a large number of switches and important road crossings, which further furnished reasons for the installation of track circuits and signals.

All of this signaling is on double track, with the exception of a stretch of one mile of single track, the total amount of track protected being 20 miles and the number of signals 130. The average length of block is about 750 ft., a few of them being as short as 600 ft., and others running to about 1000 ft.

The signaled territory includes a drawbridge, a gauntlet and two important junctions, each of the four situations requiring special signaling.

The single track section is signaled with four signals, one at each end and two intermediates, in a manner similar to the signaling installed by this company on the Washington, Baltimore & Annapolis Electric Railroad in 1912.

The three-position system of signaling with the new Model 15 light signals, displaying red for "Stop", yellow for "Caution" and green for "Proceed" is used and all signals are mounted on independent pipe posts.

Switch indicators are employed at most of the switches, these being of the light type with push buttons on the double track and light type with manual time release on the single track, all being mounted in iron cases on iron pipe posts.

The track circuits in addition to controlling the signals and switch indicators, operate grade crossing protection in the form of bell, flashing light and wigwag, there being 23 of these arrangements for the nine miles of road.

All impedance bonds are of the 500 ampere per rail type; all relay boxes are of iron mounted on signal posts; the track relays are of the galvanometer type, and the rail insulations of the Keystone type.

Power is secured from Riverview Substation near the center of the system where 350 volt, 60 cycle, is stepped up to 2300 volt for the signal system.

CHICAGO, SOUTH BEND & NORTHERN INDIANA RAILWAY

(Car Barns to LaPorte)
(LaPorte to South Bend)
(South Bend to Niles)
(Elkhart to Goshen)

These installations are extensions of the signaling installed by this company for the same road in 1913.

The apparatus and system are the same,—the T. D. B. system for single track, and includes 72 two-position Style "B" bottom post mechanism signals protecting 48 miles of track, the average length of block from siding to siding being 2.5 miles.

NORTHERN TEXAS TRACTION COMPANY

(Mt. Creek to Boundary)

This, the initial installation for this road and the State of Texas, protects 5.4 miles of single track with three blocks and twelve signals. The T. D. B. system with Model 13 light signals and switch indicators of the semaphore type with manual time release is used.

SUMMARY OF SIGNALING INSTALLED BY THE UNION SWITCH & SIGNAL COMPANY ON INTERURBAN ELECTRIC RAILWAYS, JULY 1, 1914, TO JULY 1, 1915.

	Miles of track protected	Type of signals		Remarks
		Sema.	Light	
Chicago, South Bend and Northern Indiana Railway	48.0	72	.....	T. D. B. system.
Detroit, Monroe and Toledo Short Line	1.6	3	.....	Gauntlet and switch protection.
Indiana Railway and Light Co.	7.1	.....	8	T. D. B. system.
Michigan United Traction Co.	3.0	4	.....	T. D. B. system.
Northern Texas Traction Co.	5.4	.....	12	T. D. B. system.
Rhode Island Company	20.0	.....	130	Double track.
Scranton and Binghamton R. R.	12.0	16	16	T. D. B. system. Second installation.
Totals	97.1	95	166	

Number of miles of track blocked by the T. D. B. system ...	82.1
Number of signals, T. D. B. system	128
Total number of miles of track blocked by continuous alternating current track circuits	97.1
Total number of signals controlled by continuous alternating current track circuits	261
Number of miles of track blocked to date by the T. D. B. system	259.1
Number of signals installed to date, T. D. B. system	444

GENERAL RAILWAY SIGNAL COMPANY

The only installations this company has to report at this time are the cab-signal and speed-control mechanism on the Brooklyn Rapid Transit System, which was described in the *Electric Railway Journal,* May 8, 1915, Vol. 45–19, page 872, and the electric interlocking installation on the Pacific Electric Company at Watts, Cal., which was also described in the *Electric Railway Journal,* May 15, 1915, Vol. 45–20, page 946.

APPENDIX B

SIGNAL INSTALLATIONS

American Electric Railway Engineering Association
American Electric Railway Transportation and Traffic Association

Joint Committee on Block Signals for Electric Railways

Data Sheet No. 126. January, 1915.

Company.....

City..... State.....

1. Miles of single track signaled?.....Of double track?.....
2. Number of signals?.....Average length of block?.....
3. Type of signal.....(a) Track circuit?.....
   (b) Contract?.....
4. Make of signal?.....
5. If track circuit.....(a) Top post mechanism?.....
   (b) Bottom post mechanism?.....
6. If contact.....(a) Trolley?.....(b) Third rail?.....
7. Cost of maintenance (*Not* including highway crossing signals)

Year ended.....	1913	1914
Labor.....		
Material, 1913.....		

8. Number of signal movements?.....
9. Number of signal failures?.....
10. Number of signal interruptions?.....

Note.— **Signal Failure**..... " False clear " indication.
Signal Interruption..... In which a signal fails to give its proper indication when not prearranged.

11. How many signal maintainers do you employ?.....
12. Do these maintainers look after highway crossing signals?.....
13. If so, how many?.....
14. What effect have signals had on traffic?.....
15. What headway could be operated during rush hours:
    (a) Before signaling?.....
    (b) After signaling?.....
16. Maximum schedule speed?.....

Signed.....

Date..... Title.....

Note.— This information blank is sent you in duplicate form. Please fill in the information asked for at your earliest convenience and return one copy to American Electric Railway Association, 8 West 40th street, New York, N. Y.

KEY TO COMPANIES

The following companies have furnished information which is tabulated on the Summary of Track Circuit Signals.

CALIFORNIA:

103. Oakland, Antioch and Eastern Railway Company, Oakland, Cal.

ILLINOIS:

107. Illinois Traction System, Peoria, Ill.

INDIANA:

108. Chicago, Lake Shore & So. Bend Ry. Co., Michigan City, Ind.
Chicago, South Bend & Northern Indiana Traction Co., So. Bend.
109. Southern Michigan Railway Company, South Bend, Ind.
113. Indiana Railways & Light Company, Kokomo, Ind.
115. Terre Haute, Indianapolis & Eastern Traction Co., Indianapolis.
116. Union Traction Company of Indiana, Anderson, Ind.

MARYLAND:

118. Washington, Baltimore & Annapolis Electric Ry. Co., Baltimore.

MISSOURI:

120. Kansas City, Clay County & St. Joseph Ry. Co., Kansas City.

NEW JERSEY:

122. Public Service Railroad Company, Newark, N. J.

NEW YORK:

124. Empire United Railways, Syracuse, N. Y.
127. New York State Railways, Utica, N. Y.

PENNSYLVANIA:

134. Scranton & Binghamton Traction Company, Scranton, Pa.

WASHINGTON:

136. Washington Water Power Company, Spokane, Wash.

TRACK CIRCUIT SIGNALS

Key	Miles of track signaled		Number of signals	Average length of block (feet)	Make of signals	Mechanism (top or bottom post)	Cost of maintenance 1914		Number of signal movements 1914	Key
	Single	Double					Labor	Material		
103	85.0	None	(sets) 60	6,000	U. S. & S. Co. 13-A	Top post	$3,503 00	$1,376 00	3,600,000	103
107	124.1	3.0	302	7,400	U. S. & S. Co. style B (256); 5" Light signal (38)	Bottom post	2,463 00	1,351 00	4,691,640	107
108	60.0	2.0	84	13,580	U. S. & S. Co.	Bottom post	1,472 00	702 00	1,161,342	108
109	17.0	.....	42	10,560	U. S. & S. Co. (20)	Bottom post	201 00	70 00	206,654	109
113	11.95	.....	14	15,840	G. R. S. Co. & U. S. & S. Co.	.....	10 00	5 00	14,600	113
115	33.05	.....	38	13,250	G. R. S. Co. & A. P. B. 3-light	.....	.....	.....	540,995	115
116	49.9	.....	76	8,980	G. R. S. Co. (light)	Bottom post	1,000 00	225 00	1,174,308	116
118	13.0	.....	36	7,433	U. S. & S. Co.	Bottom post	500 00	170 00	941,778	118
120	71.76	.....	100	15,840	U. S. & S. Co., Home sig. type B; Intermediate No. 13	Bottom post	.....	.....	.....	120
122	9.34	.....	30	9,250	U. S. & S. Co.	Bottom post	.....	.....	531,012	122
124	24.5	5.8	47	5,070	U. S. & S. Co.	Bottom post	1,838 00	751 00	1,199,436	124
127	.....	13.2	18	(1) 5,900 (2) 14,500	U. S. & S. Co. (T-2)	Top post	987 00	105 00	704,892	127
134	24.0	.....	36	7,000	U. S. & S. Co. (T. D. B.)	Bottom post	236 00	*43 00	621,656	134
136	22.5	.....	29	4,772	G. R. S. -2-A overlap; S. P. A. C.	Top post	996 00	140 00	422,321	136

Average cost of maintenance, including labor and material, per signal blade, per month, 1914, $2.20.
Average cost of maintenance, including labor and material, per signal-mile, per month, 1914, $0.98.
* Six months.

TRACK CIRCUIT SIGNALS

Key	Number of signal failures 1914	Number of signal interruptions 1914	Number of signal maintainers employed	Do these maintainers look after highway signals?	If so, how many?	Effect of signals on traffic	Headway during rush hours: Before signaling *Minutes*	Headway during rush hours: After signaling *Minutes*	Maximum schedule speed M. P. H.	Key
103	.....	126	3.....	Yes.....	14	No check.....	(Road not in service until after signaling).....		34	103
107	16	1,628	7.....	Yes; also telephones.....	27	No effect. Headway not sufficiently close or sidings far enough apart..	10.....	10.....	50	107
108	.....	196	2.....	Yes; also all switch lights..	4	Difficult to determine....	10.....	10.....	55	108
109	1	220	No special one..	No.....	.....	Assists in traffic.....	No definite figures. City	Int.	10 30	109
113	.....	30	None.....	.....	.....	None.....	Same as before.....		50	113
115	.....	386	Linemen do this.	.....	.....	None.....	60.....	60.....	60	115
116	1	506	1.....	No.....	.....	None, except as to safety. Slight delays due to occasional interruption.	No difference. Hourly headway. Could operate 10 minute headway..		60	116
118	.....	2,300	1.....	No.....	.....	Increased.....	5.....	5.....	31	118
120	.....	.....	.....	No.....	.....	As an advertisement believe business has been increased.....	15.....	15.....	30	120
122	6	326	1.....	Yes.....	10	None.....	.....	.....	31.8	122
124	4	140	1.....	No.....	.....	Aided.....	.....	.....	42	124
127	6	35	1.....	Yes.....	2	Aided; decreased conjestion.....	5.....	2.5.....	30	127
134	5	68	2.....	Yes.....	7	Eased running time.....	15.....	15.....	20	134
136	19	1	1.....	Yes.....	1	None.....	30.....	30.....	28	136

APPENDIX C

HIGHWAY CROSSING SIGNALS

American Electric Railway Engineering Association
American Electric Railway Transportation and Traffic Association

8 West 40th street, New York, N. Y.
Joint Committee on Block Signals for Electric Railways

Data Sheet No. 125 January, 1915

Company.....

City..... State.....

List all automatic crossing signals used or on order, giving the following information:

	TYPE	TYPE	TYPE
1. Make and Type			
(*a*) Number of each type			
(*b*) Character of Indication			
Audible			
Visual (Day)			
Visual (Night)			
(*c*) System of Operation			
Track Circuit — A. C. or D. C.			
Insulated rail section			
Track instrument			
600 volt			
Miscellaneous			

2. Have bells time limit device to prevent continual ringing?.....

3. Is such a device desirable?.....

4. List causes of failures, each type, in order of importance.

.....

.....

.....

5. Suggest any improvement you consider desirable, such as new form of indication, etc.

.....

.....

6. What other signs or indications do you use to show approach to your railroad crossings? (Please enclose diagrams if possible.)

.....

7. Give any figures on maintenance and inspection, subdivided, if possible, as to labor and material.

.....

.....

.....

.....

APPENDIX C — SUMMARY OF INFORMATION COLLECTED ON HIGHWAY CROSSING SIGNALS.

Key No.	Company	Kind	Total number	Character of indication: Audible	Visible day	Visible night	System of operation: Track circuit A. C.	Track circuit D. C.	Insulated section	Track instrument	Third rail and trolley contactor	600 volt	Miscellaneous	No. 2: Have bell tune limit device to prevent continual ringing?	No. 3: Is such a device desirable	No. 4: List causes of failures. Each type in order of importance	No. 5: Suggest an improvement you consider desirable, such as new form of indication, etc.	No. 6: What other system or indications do you use to show approach to your railroad crossings? (Duration of time)	No. 7: Give any figures on maintenance and inspection subdivided, if possible, as to labor and material — Labor	Material	Remarks	No. 8: How many signals of the different kinds can one man look after?	No. 9: What period between inspections is allowable with different types, and what does this mean in mileage?	No. 10: What does it cost in labor and material to install one bell, one and two track relays and one pole and operating mechanism? — Single track	Double track	No. 11: What is customary distance for placing operating device of bell from crossing protection?	No. 12: What relation should this distance bear to the speed of trains at that point?	Key No.
1	Aurora, Elgin and Chicago	Hoeschen, 35, National, 29.	64	64						15	29	20		15	Yes	Hoeschen, track bearing, National, failure of insulation and contactors, lamps burning out.												1
2	Chicago Interurban Traction	Keystone, 2	2	2							2										No record							2
3	Chicago, Ottawa and Peoria	Hoeschen, 3, Cook Grate.	1	1	1					4		1		1		Hoeschen, heaving track; ice and dirt under rail; Cook, batters trouble, track instruments out of adjustment	Pilot light for motormen				No record					800' to 1,000'	Distance arranged to take care of trains on a one or two minute headway.	3
4	Chicago and Milwaukee Elec	Home made	29	29		29				29		27				Adjustments, lightning, burned out fuses and lamps					No record							4
5	Chicago Lake Shore and South Bend	Hoeschen, 4	3							3				1	Yes	Practically none												5
6	Cincinnati Eastern Traction	Beattie, 1-11	2											0		Men traversing around broken rail section			$2.00 per mo	$1 per mo	Current 180 days hire per mo.	$0.25 per man						6
7	Denver Tramway Co	Home made, 2	2								2	2		0 K				Lamps behind red glass										7
8	Detroit United Railway	Hoeschen, 50	50	50						50				0	Yes	Very few	Danger light at night	Green	Mostly labor,	$3.50 per bell per mo	$25.00 material, maintenance and other items	12 bells, 6 train order signal, 20 switch light						8
9	Empire United Railways	Hoeschen													Yes	Lamps, trouble from landing												9
10	Fresno Traction Co	Hunt Auto flagman	4	4			4					4		1	Yes	None		Green			Not available		We do		$17.21	$63.21	20'	None	10
11	Grand River Valley Ry. Co.	National Elec. Mfg., 2	2	2							2	2			Yes	Does not always cut out	Better terminal contact, also cut out								Approximately $175	500'			11
12	Hattiesburg Tract Co	Make not given, 1.	1																									12
13	Illinois Traction Co	Hoeschen, 26, Brach, 1	27		6	6				26	1			21	Yes	Track conditions. Open bell, coil, poor drainage, moisture, wind up	Pilot light for motormen. Stop operation if bells are burnt out.	Standard Code. "Stop R.R. crossing. Look out for cars"	$.15 per bell per month.	$.31 per bell per month.		Under this heading to 2,000 miles	2 each month, 1 to 650 operations	$15.00 per bell. Labor $10.00 material $50		Depends on speed	We attempt to have bell ring from 20 to 30 seconds before train arrives	13
14	Kansas City, Clay Co. and St. Joe.	Hoeschen, 6, Protective 2.	8	8						6				8	Yes	Hoeschen, tripping and winding devices fail, protective, battery trouble.	None	Sign			Not started	About 10		$75.00		1,800'		14
15	Louisville and Interurban	Hoeschen, 5								5				5	Yes	Magnets demagnetize bells run down.	Light for night use.		Very little	Nothing		Line gang	Yearly for adjustment	Approximately $125.00	800' to 1,000'	Direct ratio to speed, also on whether crossing is visible from train	15
16	Mahoning and Shenango Ry. and Light	Home made, 2	2								2				Yes	Signal cutting out		Sign			Not available owing to small number				1,000'		16.
17	Metropolitan West Side Elev	Hoeschen, 7, National, 1 / Parsday, 29, Ball Lamp	37	37							28	9		5	Yes	Hoeschen track conditions, Parsday, burnt out lamps, broken hammers etc.		Some gates, some flagman			Grouped with all repairs	Cannot answer	Each day	Hoeschen $10 / Parsday $50	600' to 1,000'	Depends on speed, further than 1,000' increases as speed increases	17.
18	Minneapolis and St. Paul Suburban	Home made, 8, Nachod, 1	9	9							9	9		9	Not yet in factory	Relay failures, fuses, contactors, lamps, batters	Signal circuit separated from trolley, indication for motormen	Some signs			On crossings			Parsday $50			18
19	New York State Railways	Brach, 2	2	2		2				2				1	Yes	Track contacts out of adjustment	Improvements in track instrument	Sign			Not installed long enough	18 block signal, 12 switch and 2 crossing signals, est. 20 bells	Daily	$75.00	$100.00	1,200' to 1,500'	This distance up to 25 M. P. H.	19
20	Oakland, Antioch and Eastern	Auto flagman	11	11	11	11	11															By regular signal maintainer	3 times per week			2,000'	2,000' for 30 M. P. H., increase 500' for every 5 M. P. H.	20
21	Oregon Electric Railway	Hoeschen, 12, Auto flagman, 1.	15	15		15		11			12	12	11	Yes		Hoeschen failure to wind, auto flagman trouble, contacts and burn out	Indication to motorman when bell is not ringing	Sign					30 days	$450.00	$150	1,500' to 2,000'	Should vary with square of speed	21
22	Pacific Electric	Ry. Spec. Co., Auto flagman.	112	1	112	112			111	111																		22
23	Public Service Railway Co	Brach auto flagman	16	16	16	16				16				16	Yes	This was original installation and trouble with track instruments and wood	Better indication to motorman when operating	Sign				1 man 10 bells, 30 signals	General, 1 per week, close, 1 per month up.			2,000'	Should have about 30 second ringing before train reaches crossing.	23
24	Puget Sound Electric Ry Co	National, 6	6	6	6	6				4						Burnout resistance and relay coils			$1.17 per month	$.67 per month		Signals maintained along with other work	Weekly	Labor $50 $60, material, $40 $50	1,500'		24
25	Salt Lake and Ogden Ry	Hoeschen, 2	2	2	2	2				2				2	Yes	Poor drainage at bell, lightning burn-out	Types with arms subject to interference by boys removing arms				So signal as to be negligible. Maintained by track men						25.
26	Scranton and Binghamton	Brach, 7	7	7		7				7					Yes	Most failures due to expansion and contraction						15 in winter, 25 30 in summer	30 days	Approximately $55.00	1,000' where cars approach at 15 or more M. P. H.	Where operating conditions are not so favorable some contacts are only 700' from crossing.	26.
27	Southern Pacific Co	Ry. Spec. Co., 11 Auto flagman, Hoeschen, 6 U. S. & S. motors 1	21	21	11	17				6			4 bells	6	Yes	Induction type trolley contactors. Three circuit breakers at two locations		Sign	$2.00 per signal per mo. (est.)	$1.00 per signal per mo. (est.)		With bells, 1,000 signals and no other duties, 50	Trolley contact, daily, others, 1 per week.	Hoeschen, about $150 labor, $100 material, $650 Ry. Spec., slightly less	1,500'	Signals should operate at least 30 seconds before train reaches crossing.	27
28	Terre Haute, Ind. and Eastern	Hoeschen, 1		1	1	1				1																		28
29	Union Traction of Indiana	Protective, 1; National, 1	2	2	1	1				1	1			2	Yes	Poor bells, batteries, National bell circuits and lights		Sign			Repairs included						29
30	United Ry's of Portland, Ore	Hoeschen, 8	8	8	8	8				9				8	Yes	Failure to feed	Indication to motorman when bell is not ringing	Signs						Protective $120.55	1,500'	About twice braking distance, track conditions considered.	30
31	Washington Water Power Co	Hoeschen, 1	1	1						1						No trouble								$450.00	$150	1,500' to 2,000'	Should vary with square of speed	31.
32	Waterloo, Cedar Falls & Northern	Hoeschen, 6	6	6						6				6							No record							32
33	West Penn Ry's Co	Hoeschen, 1	1	1	1	1				1				1	Yes			Signs 100 ft. from crossing.			Present installed			$377.28 [18]				33
34	West Side Elec St Ry Co	Nachod, 2	2	2	2	2			2									Signs										34
	Totals		516	513	409	377	11	3	234	1	112	111		112														

[1] 13 bells, 283 movements daily, 42 bells, 107 movements daily, 10 bells, 80 movements daily, virtual day and night. [2] Apparently includes apparatus. [3] Claims allowing bells to ring gives check on maintenance. Says this may be desirable in thickly settled districts. [4] Home made signals — Not yet on market. [5] Considering lights visual in day time. [6] Includes changing complete flagman at end of 24 months. [7] Considering lights visual in day time. [8] Assuming bank of lamps visual day and night. [9] Lights considered visual day and night. [10] Train movements from 250 to 680 per week. [11] Red lights considered visual in day and night. [12] Considering lights visual in day time. [13] Apparently includes apparatus. [14] With proper supervision of maintenance there should be no limit. [15] Apparently includes apparatus. [16] Lights considered visual day and night. [17] 2 cars per hour 20 hours daily.

8. How many signals of the different kinds can one man look after?

.....

.....

9. What period between inspections is allowable with different types, and what does this mean in train movements?

.....

10. What does it cost in labor and material to intall each type; single track and double track?
(Above is exclusive of price paid to maker for bell and post, relays and operating mechanisms.)

.....

11. What is customary distance for placing operating device of bell from crossing protected?

.....

a. What relation should this distance bear to the speed of trains at that point?

.....

.....

Please send prints of any of your crossing installations, and state if you have the film or negative, and would be willing to loan it for making lantern slides.

Signed.....

Date..... Title.....

NOTE.— This information blank is sent to you in duplicate form. Please fill in the information asked for at your earliest convenience and return one copy to American Electric Railway Association, 8 West 40th St., New York, N. Y.

APPENDIX D

Form No. .... Pages
Compiled by .....
Approved .....

SIGNAL ESTIMATE DATA SHEET FOR A. C. TRACK CIRCUIT SIGNALING ON AMERICAN ELECTRIC RAILWAY COMPANY

The Railway Company shall give the Signal Company as much of the following information as possible in order to facilitate the preparation of an estimate and proposal.

A line should be drawn through items not wanted or the blank spaces filled in where necessary.

I. General

1. Name of official in charge of work .....
2. Title of official in charge of work .....
3. Address .....
4. Signaling to be installed between the following points .....
   .....
   .....
5. Miles of single track ..... Double track ..... Four track .....
6. Railway Co's specifications attached. Number ..... Date .....
7. Railway Co's track plans attached. Number ..... Date .....
   Number ..... Date .....

II. Traction Power Data

8. *Power Houses*
   (*a*) State the name of each power house or substation in the territory to be signaled and show same on track plan, giving distance from track .....
   .....
   (*b*) What is the average hourly output in Kw-hrs. of each substation .....
   (*c*) What is the maximum hourly output in Kw-hrs. of each substation .....
9. *Distribution*
   (*a*) Is this by overhead trolley or third rail .....
   (*b*) D. C. volts ..... or A. C. volts ..... Cycles .....
10. (*a*) What is the accelerating current taken by the heaviest train ..... amperes.
    (*b*) What is the duration of this current .....
11. How much unbalancing of the propulsion current is likely to occur, i. e.; how much more current is likely to be carried in one rail than in the other. If rail A carries ..... amperes, rail B will carry ..... amperes.

    Note.— This unbalancing is due to poor bonding in one rail.

III. Power Supply for Signal System

12. (*a*) State location of power houses or substations from which A. C. power may be obtained for the signal system .....
.....
.....

(*b*) What is the frequency of the A. C. supply ..... cycles.

(*c*) What is the voltage available at each point of supply .....
.....

(*d*) What is the percentage variation in voltage Above .....
Below ..... Normal .....

(*e*) Is the supply single ..... two ..... or three .....
phase.

Note.— It is preferable to step up from a low voltage such as 370-v or 410-v —the rotary voltages— instead of stepping down from a high voltage, such as 11,000-v, as it is safer and cheaper to employ the low voltage.

(*f*) Shall duplicate signal power transformers be installed at each point of supply .....

(*g*) If D. C. propulsion is used state if storage batteries are employed as a reserve for traction purposes in case of failure of the A. C. power .....

(*h*) Where are these batteries located .....
.....

(*j*) Is it desired to install d. c. a. c. motor generator sets fed from such batteries to insure power for the signals when cars are operated from storage batteries on failure of the a. c. power .....

(*k*) Must signal switchboards match existing panels .....

(*l*) If so, attach plans. Numbers ..... for existing panels.

(*m*) If no plans are available give following information, for signal panels desired.

Total height ..... Width ..... Bevel .....
Material ..... Finish ..... Number of sections ..... Height of each section: Top .....
Middle ..... Bottom ..... Panel supports ..... Pipe ..... Angle iron ..... Size .....

(*n*) What instruments and protective apparatus are required on the switchboards .....
.....
.....
or shall Signal Company recommend these.....

(*o*) Are lightning arresters required at power houses and substations .....

(*p*) If so, what type .....

(*q*) Give name of manufacturer of power apparatus now in power house and substations.....

(*r*) Will Railway Company furnish and install all signal power equipment at power house and substations .....

(*s*) Or shall Signal Company furnish all signal power equipment, wire and cable for connecting this up and Railway Company install signal power equipment (furnished by the Signal Company) and also furnish and install all insulators, supports or conduit for incoming and outgoing wires and for wiring between signal switchboard and the point in the substation or power house from which power is taken .....

(*t*) Shall Signal Company furnish and install all signal power equipment, wire and cable. .....

If so, Railway Company shall submit plans showing location of existing apparatus, proposed location of signal power apparatus, show and state if wiring for signal power equipment is to be run in conduit or overhead on insulators and show where wires are run and length of runs.

Plans — NUMBERS.....

Dated .....

13. *Capacity of substation equipment:*

(*a*) Shall the signal power equipment at any substation be capable of handling the load of the next substation at which signal power equipment is located .....

(*b*) Shall it be assumed that only one substation will be out of service at any given time .....

(*c*) Or shall it be assumed that one substation might have to carry the signal load for the substation on each side of same simultaneously.

NOTE.— This will mean larger and more expensive signal equipment and is not usually advisable.

(*d*) Shall any allowance be made for any future extensions of signaling .....

(*e*) If so, between what points .....

See track plan — Number ..... Dated .....

(*f*) Is any station lighting or any other power to be taken from the signal transmission line .....

(*g*) If so, how many kv-a ..... and at what power factor .....

IV. HIGH TENSION TRANSMISSION LINE FOR SIGNAL SYSTEM

14. (*a*) Voltage ..... or shall Signal Company make recommendation .....

(*b*) Frequency ..... Cycles .....

(*c*) Phase ..... or shall Signal Company make recommendation .....

(*d*) Minimum size of wire that may be used .....

(*e*) Kind of line wire desired .....

(*f*) Distance of pole from gauge:

Maximum ..... Minimum .....

Average .....

(*g*) Pole spacing:
Maximum ..... Minimum .....
Average .....

(*h*) Will signal high tension transmission line be located on same cross arm with low tension signal control wires .....

(*j*) Or on separate arm by itself .....

(*k*) If possible give clearance diagram showing outline of maximum car and typical layout of transmission line pole, showing existing power lines and location of cross arms for signal high tension transmission line and low tension control wires. Plan ..... Number ..... Dated .....
If above plan is not available describe the arrangement. Refer to A. E. R. A. standard clearance diagram .....
.....
.....
.....

(*l*) Will Railway Company furnish transmission line poles, cross-arms, pins, insulators and all line material required by the system in place .....

NOTE.—Signal Company shall state or submit typical plan showing maximum number of signal line wires, both H. T. and L. T. at various points also giving size and kind of wire required.

(*m*) Will Railway Company furnish and string all line wire .....

(*n*) Will Signal Company furnish and Railway Company string all line wire .....

(*o*) Will Signal Company furnish and string all line wire .....

V. HIGH TENSION APPARATUS FOR SIGNAL TRANSMISSION LINE.

15. *Transformers:*
(*a*) Will transformer cases be grounded .....

16. *Primary fuses or cutouts:*
(*a*) Will primary fuses be of the porcelain plug, block type single pole ..... or iron box type, single pole .....
similar to those shown in catalogue ..... section .....
page .....

17. *High tension lightning arresters:*
(*a*) Will these be single pole ..... Double pole .....
(*b*) Similar to those shown in catalogue ..... section .....
page .....
(*c*) Will arresters be mounted on the same pole with transformer which they protect ..... or on adjacent pole .....

NOTE.—The maximum protection is secured by locating arresters on same pole with transformer.

(*d*) Railway Company's plan number ..... Dated .....
shows details of installation of arresters and transformers on pole.

18. Are S. P. S. T. high tension disconnecting air break knife switches required at power house and substations to cut station clear of transmission line .....

19. Are high tension pole type sectionalizing oil switches required .....

(*a*) To enable sections of the transmission line in trouble to be isolated .....

(*b*) How far apart will sectionalizing switches be located .....

VI. Signals and Character of Signals Desired.

20. *Kind of signaling:*

(*a*) Is curve protection only desired .....

(*b*) If so, will signals be located near curves .....

(*c*) Or at sidings so as to fit in with future continuous signaling .....

(*d*) Is continuous protection desired .....

(*e*) If single track continuous signaling, will headway for following trains equal the distance between sidings .....

(*f*) If following headway must be less than distance between sidings, give minimum headway in minutes .....

(*g*) Are semaphore signals required .....

(*h*) Are light signals desired .....

(*j*) Are semaphore signals desired at sidings with intermediate light signals .....

(*k*) Will signals be two position or three position .....

(*l*) If signals are two-position what will be the degrees movement .....

(*m*) If semaphore signals will they be upper ..... or lower ..... right ..... or left ..... hand quadrant.

(*n*) Are cab signals required .....

(*o*) Is speed control desired .....

(*p*) Are automatic stops required .....

(*q*) Are switch indicators required .....

21. *Interlocking plants:*

(*a*) Are there any existing interlocking plants .....

(*b*) Plans of existing interlocking plants attached, as follows .....

(*c*) Are any new interlocking plants required .....

(*d*) Plans of new interlocking plants attached, as follows: .....

(*e*) Type of interlocking plants:

	Existing Plants	*New Plants*
Electrical	.....	.....
Mechanical	.....	.....
Electro-mechanical	.....	.....
Electro-pneumatic	.....	.....

22. *Traffic operation:*
(*a*) Method of operating cars at passing sidings:
Does first car to reach siding take siding .....
Or does the inferior car take siding .....
Or do cars head in, back out and proceed .....
Or do cars run through at double end sidings .....
Do cars always run to the right at sidings .....
(*b*) Are there any special moves at passing sidings .....
State sidings .....
Explain moves .....
(*c*) State method of operating cars at switches not passing sidings
.....
State name of sidings .....
(*d*) Is the density of traffic the same on all parts of the signaled territory .....
(*e*) Are there any station stops at which trains must close in on trains stopping at stations .....
Give stations .....
(*f*) State any special arrangements not covered by the above
.....
.....
.....
(*g*) Employees timetable for ..... attached.
(*h*) Maximum number of extra trains on holidays, etc., ...
.....
(*j*) Maximum speed in miles per hour .....
(*k*) Maximum braking distance .....
(*l*) Give speed-time and speed-distance curves for the section of road to be signaled, if available ..... Curves number ..... Dated ..... Attached .....
(*m*) State sections where traffic varies greatly, due to amusement parks, etc. .....
.....
.....
(*n*) What is the weight of the lightest car used ..... tons.
(*o*) What is the length of shortest car between truck centers ..... feet.
(*p*) What is the average length of trains ..... feet.
(*q*) What is the maximum length of trains ..... feet.

23. *Highway crossing protection:*
(*a*) Are highway crossing signals required .....
(*b*) If required, will control be by track circuit .....
(*c*) Will signal Company submit supplemental proposition on highway crossing protection .....

VII. Track Construction.

24. *Rails:*
(*a*) Weight of rails in pounds per yard .....

(*b*) What is the rail section ..... Weight .....

NOTE. — If rail weight and section vary, indicate this on track plan if one is drawn up.

(*c*) Are the rail joints opposite or staggered .....

(*d*) What is the stagger of joints in feet .....

(*e*) Will Railway Co. cut rails so as to match the insulated rail joints at ends of track circuits .....

25. *Bonding*

(*a*) State size, number per joint and kind of rail bonds ....

(*b*) Is it desired to cross bond between tracks if road is double track .....

(*c*) Will Railway Co. furnish and install all cross bonding cables and terminals .....

(*d*) Will Railway Co. furnish all power bonding to sidings or switches and power jumpers around frogs and switch points .....

26. *Ballast*

(*a*) What kind of ballast is used — Rock ..... Gravel ..... Dirt ..... Cinders .....

(*b*) Are the rails free from the ballast .....

(*c*) Do they touch the ballast .....

(*d*) Is the ballast up around the rails .....

(*e*) If the ballast is up around the rails will Railway Company clear same from the rails before track circuits are put in service .....

NOTE.— Ballast, especially dirt, gravel or cinders, up around the rails, means that shorter track circuits must be used to avoid trouble in wet weather. Cinders are especially bad and track circuits cannot be expected to work satisfactorily when cinders are up around rail.

(*f*) Is the track well drained .....

(*g*) Do the rails make metallic contact with the floor or girders of any bridges or other structures .....

(*h*) If so, will the Railway Company insulate the rails at such points from the other metallic structure .....

(*j*) Or is it desired to put in a dead or non-track circuited section at such point and protect by means of a trap circuit .....

(*k*) Will the Railway Co. remove all cross bonds between rails or tracks and all tie rods .....

(*l*) Does the Railway run in or close to a highway at any points .....

(*m*) If so, is the dirt up around the rails .....

(*n*) Are treated ties to be used .....

(*o*) If so, state what kind .....

VIII. TRACK PLANS

If possible give a complete *scale* plan giving the following information. This is necessary in order to enable the Signal Company to make an accurate estimate.

27. Show mile posts, chaining stations and *scale* of plan.
28. (*a*) Shall all existing and proposed switches or sidings indicating at *each* whether *passing* or *industry* only.
    (*b*) Show switch indicators at switches where desired.
    (*c*) Indicate length of sidings.
    (*d*) Indicate if normal position of switch point is for main line or siding.
    (*e*) State number of switch rods at each switch.
    (*f*) Indicate for *each* switch if of the spring type, hand throw or rigid type.
29. Give profile if possible.
30. Give alignment of curves, designating length and if possible whether the view across the curve is obstructed.
31. Location of stations or depots.
32. Location of all substations and power houses, designating those at which power for the signal system can be obtained and distance from nearest track.
33. Location of any drawbridges, stating type of signals or de-rails, if any, installed for protecting same.
34. Indicate highway crossings where crossing bells are desired and the warning distance in each direction.
35. Location and length of track in paved streets.
36. Show grade crossings or junctions with steam or electric lines. If interlocked, furnish plans for same.
37. Show signal locations if decided upon by the Railway Company.
38. Show location of pole line with reference to tracks.
39. Show distance from each signal location to nearest transmission line pole.

SIGNAL ESTIMATE DATA SHEET FOR CONTACTOR SIGNALS

The Railroad Company will give the Signal Company as much of the following information as possible.

1. Track plan of the track to be signalled, wherever possible.
   This is important for often it is found by looking over the track plan that there is something special which is required in properly taking care of all movements which may be made.
2. Voltage on the line to be signalled so that the proper resistance can be furnished with the signal.
3. Scheduled speed of operation of the cars.
4. Schedule of car operations where possible.
5. Size and shape of the trolley wire.
6. State whether bracket construction or span construction is used.
7. State whether a single or double trolley wire is used, as this affects the arrangement of the contactors.

REPORT OF COMMITTEE ON STANDARDS CONCERNING CERTAIN RECOMMENDATIONS OF THE JOINT COMMITTEE ON BLOCK SIGNALS FOR ELECTRIC RAILWAYS

1914-1915

Recommendation of Joint Committee on Block Signals for Electric Railways:

(*a*) As STANDARD. Design of Signal Apparatus. Fig. 2 to 12 inclusive as shown on pages 147 to 155 of this report.

Action of Committee on Standards:

Adoption as Recommended Design approved.

Recommendation of Joint Committee on Block Signals for Electric Railways:

(*b*) As STANDARD. Clearance Diagram for Semaphore Signals as shown on page 157 of this report.

Action of Committee on Standards:

Referred back to Committee to consider with the Committee on Heavy Electric Traction.

Recommendation of Joint Committee on Block Signals for Electric Railways:

(*c*) Changes in Sec. Ss 5a of Engineering Manual — Light Aspects in Three-Position Signaling, Employing Signals Operated by Contactors. That words "Non-Car Counting" and "Car Counting" be changed to read "Non-Registering" and "Car-Registering". (See page 181.)

Action of Committee on Standards:

Changes approved.

Respectfully submitted,
C. F. BEDWELL,
W. G. GOVE,
E. R. HILL,
A. S. RICHEY,
J. W. WELSH,
C. S. KIMBALL,
E. B. KATTÉ,
W. H. SAWYER,
F. R. PHILLIPS,
J. H. HANNA,
C. H. CLARK,
MARTIN SCHREIBER, *Vice-Chairman,*
H. H. ADAMS, *Chairman,*
Committee on Standards.

H. A. NICHOLL:— Our committee was composed of eight members, and each of the members had just a small portion of the work assigned to them, and so I am really not in a

position to discuss the whole report. However, I shall be glad to answer all questions so far as I am able on the subject of the report.

Discussion of Report of Committee on Block Signals for Electric Railways

PRESIDENT CRECELIUS:— Gentlemen, it is desired that our action be confined in the beginning to the definite recommendations of the Committee and to consider these recommendations in connection with the action of the Committee on Standards. The first matter for consideration is that the Design of Signal Apparatus shown on pages 147 to 155 of this report, Fig. 2 to 12 inclusive, be approved.

The Committee on Standards has approved these for adoption as Recommended Designs.

C. R. HARTE:— I move that that action be approved.

L. M. PERRIN:— In connection with the design shown in Fig. 2, I would like to ask the Committee whether it is intended to standardize the bottom-post type of signal, to the exclusion of other types, or will other drawings be developed covering the top-post signal which is in extensive use on electric railways.

H. A. NICHOLL:— I imagine that matter will be given attention by the ensuing Committee.

ACTING SECRETARY STOCKS:— It is my understanding that the Committee on Block Signals is working toward a standardization of all the apparatus that is used in block signal work. Last year it will be remembered that a Design of Spectacle for Left-Hand Upper Quadrant 90 deg. Semaphore Signal was submitted, and this year the design includes all other parts of signals of the semaphore type. The idea is to standarize block signal equipment, and the work is to be carried on each year until a complete system of standards is obtained as applying to signal apparatus.

J. J. DEMPSEY:— Some of the roads are getting away from the flag signal and using the light instead. Is it the intention of this Committee to recommend as standard a blade signal, ignoring the light?

H. A. NICHOLL:— I do not understand it so at all. They are only recommending what should be the standard for a blade signal. They do not recommend that a company should use any blade signal. A company can use a light signal, if it prefers to. Our company uses the light signal entirely, and expects to continue to use it.

PRESIDENT CRECELIUS:— Is there any further discussion? Are you ready for the question?

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is with regard to the Clearance Diagram for Semaphore Signals as shown on page 157 of this report.

The Committee on Standards recommends that this be referred back for consideration with the Committee on Heavy Electric Traction. What is your pleasure in this matter?

C. R. HARTE:— I move that the recommendation of the Committee on Standards be approved.

(Motion duly seconded, stated and carried.)

ACTING SECRETARY STOCKS:— Last year, as I said before, the Committee on Block Signals presented for adoption a Design of Spectacle for Left-Hand Upper Quadrant 90 deg. Semaphore Signal. This design, as submitted last year, was for adoption as standard. The 1914 Convention approved of the recommendation, but the Committee on Standards of the Engineering Association saw fit to only approve this as a Recommendation to agree with the Recommendations which you have just approved, and as a result this Design of Spectacle now needs the approval of this Convention, in order to cover the routine work of the Association.

C. R. HARTE:— I move that the action of the Committee on Standards be approved.

PRESIDENT CRECELIUS:— Gentlemen, you have heard the motion made to approve the recommendation.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is with regard to changing some wording in our Standard Light Aspects in Three-Position Signaling, Employing Signals Operated by Contactors. It is recommended that the words

"Non-Car Counting" and "Car Counting" be changed to read "Non-Registering" and "Car Registering." (See pages 181 and 224.)

It is the only change recommended by the Committee. The Committee on Standards approves this change. A motion is in order to adopt the recommendation of the Committee.

C. R. HARTE:— I move that the Committee's recommendation be adopted.

PRESIDENT CRECELIUS:— Is there any discussion?

(Motion duly seconded, stated and carried.)

(PRESIDENT BRUSH in the chair.)

PRESIDENT BRUSH:— The next subject is the report of the sub-committee on Block Signal Rules appearing on pages 158 and 159, and immediately following is the set of rules for block signal operation.

These block signal rules have not as yet been adopted as a Standard Code of the Association.

PRESIDENT BRUSH:— I understand that these rules, enumerated on pages 161 to 179, include the rules that have been adopted in the past as Standard Rules for Block Signals, and also additions or amendments and that they are not now being recommended by the Committee for adoption?

On the question of your regular book of rules for operation, we have taken up from year to year the question of the adoption of individual rules, and yesterday in the Transportation and Traffic Association we adopted changes in the existing Interurban Code of Rules.

PRESIDENT CRECELIUS:— Reading from page 159 of the report — "The complete code of signal rules, covering all types is given below but your sub-committee, however, recommends this revision be presented to the Transportation and Traffic Association, merely as a progress report to be used where present need exists for the guidance of member companies."

PRESIDENT BRUSH:— It would appear, in view of what Mr. Crecelius read, that it would be improper to adopt this as a standard code of rules, when the Committee requests that further consideration be given to the subject, and that this report be merely presented at this time for the guidance of the member companies who are preparing rules.

It is, therefore, only necessary for the joint meeting of the two Associations to receive this report. Then the Executive Committees of the Associations can make such appointments as they see fit for another year for the further consideration of the subject.

To bring this matter before us in a proper way it would be in order for some one to move that the report be accepted.

C. R. HARTE:— I move that this report be accepted, and if that does not automatically call the attention of the Executive Committee to the recommendation of the Joint Committee I suggest and if it is in order will offer a formal motion that the Executive Committee be advised it is the sense of the Joint Committee that the matter be taken up by a Joint Conference Committee of the American Electric Railway Association and the American Railway Association, to secure so far as it may be practicable, uniformity of practice.

J. N. SHANNAHAN:— In regard to what Mr. Harte says, my experience in this particular situation is that when we desire to get together with the American Railway Association we do as they say. We are not considered in any way whatsoever, and we need not delude ourselves with the idea that we will be considered. If we wish to send a representative to them they will treat that representative politely, and then he can come back and recommend that we do precisely what they have done. I think it is a waste of time, to do that, and we should do what seems to us right. But to attempt to get them to make an allowance to suit us, is wholly out of the question.

PRESIDENT BRUSH:— What would be your suggestion with regard to instructions to the incoming Executive Committee with regard to this report?

J. N. SHANNAHAN:— My impression would be that the Executive Committee has full power to do as seems wise to them. It may be that in the past few years a change has come over the American Railway Association, and now they would be willing to permit us to join in their councils, to some extent, and that could be easily ascertained. I should think that the Executive Committees of the two Associations should be left to do as it seems wise to them, and that we make no specific, definite recommendation.

C. R. HARTE:— I have this to say in answer to Mr. Shannahan's statement — we have before us the definite recommendation of our Committee that such a Joint Committee would be desirable. I happen to have been a steam railroad man before I came into the electric side and I know perfectly well that a comparatively few years ago the electric railway was looked upon as a pretty small kitten in the batch, but there has been decided change. In our electric railway work there are certain features which cause variation from steam railroad practice, but in many respects there should be no differences, and particularly in this matter of signals there is much which we have in common. Many of the engine men on heavy electric service are drafted from steam road service, and much of this operation is over what were originally — and not infrequently are yet — steam road lines. We do not want any differences in practice that can be avoided, and to that end we must work together and, if need be, educate our railroad friends to the errors of their ways. What particularly appeals to me here is that our Joint Committee says it "recommends this matter be taken up at once," and my object in the motion is to uphold the hands of the Joint Committee in its suggestion.

PRESIDENT BRUSH:— Have you any comment to make, Mr. Shannahan, in view of what Mr. Harte has said?

J. N. SHANNAHAN:— I have nothing further to say.

F. W. COEN:— I agree with Mr. Shannahan in this matter. It seems, to me for the asking, we can secure all the rules and everything bearing on them, so far as the American Railway Association rules on block signaling are concerned, and when we have that information we can use whatever seems to be the best for us, and allow our own Committee to formulate it, if it has not already been done, and I believe we will get as good results as could be secured in any other way, and perhaps much more quickly.

I also feel certain that the policy that has been adopted heretofore by a number of steam railroads as to the electric railway properties is changing. Some of them have come to the conclusion that the steam railroad proposition and the electric railway proposition are two different matters, that

they are quite separate and distinct, and it seems to me that the same policy should be followed here.

PRESIDENT CRECELIUS:—That last paragraph on page 159 of the Committee report emphasizes very clearly the necessity of such joint coöperation, for the reason that the whole question of signal precedure is undergoing a change at this time. (Reads last paragraph on page 159.)

H. A. NICHOLL:— Mr. C. H. Morrison, who is the engineer for the New York, New Haven and Hartford Railroad, is, as you all know, a member of this Committee. He was a member also of the Signal Committee of the American Railway Association, and it was due to the suggestion of Mr. Morrison that this recommendation was made. He stated to our Committee that the American Railway Association was at that time trying to get together on a new Code of Signal Rules, to improve their signals, and he thought it would be very desirable if a member of our Association could be appointed to meet with the Signal Committee of the American Railway Association.

C. R. HARTE:— There is one phase of all joint work which I think it is well for us to bear in mind,— it was the underlying thought in the Joint Committee action of several years ago in the matter of a Standard Overhead Transmission Line Crossing — and that is this: if the various bodies which are interested in any particular development of an art are agreed as to what is the proper practice of that art, then all hands are put on a more solid footing in case of disturbances in these days when public service commissions of all sorts, as well as the courts, are regulating affairs. It seems to me that just as far as possible we want to be in harmony with those of our friends who are doing the same general class of work that we do. If we of the electric railways can agree with other users in a general way upon a signal code, or upon signal procedure, or any other common practice, we are all in a far better position if there is an accident on our road, or any question is raised in the courts, as to why we did thus and so.

PRESIDENT BRUSH:— It should be borne in mind that the incoming Executive Committee will, of course, have the benefit of this discussion which is taking place at this meeting. I

merely mention that, so that you can decide whether or not you want to issue definite instructions to the incoming Executive Committee, or simply give them the benefit of this discussion and permit them to use their own judgment in regard to carrying out the details of this recommendation.

C. R. HARTE:— My recommendation was not in the line of instructions — it was merely a suggestion — it seemed to me this meeting should either go on record as approving the recommendation, and ask the Executive Committee to give it due consideration, with the weight of our discussion upon it, or it should say that the Committee has done well, but we do not quite agree with them in what they have put forth, and we think it advisable not to adopt the recommendation.

J. N. SHANNAHAN:— I seem to have misstated my meaning, or I have been misunderstood. I do not think we can get away from the steam railroads in their practice, and I am not arguing with that idea, for a moment. The Committee in its report says — "or at least an accredited representative of the American Electric Railway Association on the Committee of the American Railway Association when the signal rules are revised and your Committee recommends this matter be taken up at once." Who is going to appoint that accredited representative? Is the president of the Engineering Association or the president of the Transportation and Traffic Association? I should say that this motion should be "Appointed by the president of the Parent Association." I think probably that is a subject which should properly go to the Executive Committee or the president of the American Association, and we have no power to act on it — certainly the American Railway Association will not entertain a representative from one of the subsidiary organizations. If they entertain any one, they will insist on having a man as an accredited representative that was appointed by the president of the American Association.

PRESIDENT BRUSH:— It seems to me the proper action would be to receive the report as a progress report, which is substantially what it is, and refer the subject to a Joint Committee of the Engineering and the Transportation and Traffic Associations.

J. N. SHANNAHAN:— Why not refer it to this Committee — why go further?

PRESIDENT BRUSH:— To a Committee of the same personnel? Would it not be in the jurisdiction of the incoming Executive Committee to appoint the same members on the Committee, if they desire to, or change the members of the Committee, if they thought that was desirable? Or we might provide that the Executive Committees of the Engineering and Transportation and Traffic Associations request the Executive Committee or the president of the American Association to appoint an individual to secure such information as is necessary from the American Railway Association.

J. N. SHANNAHAN:— There is no doubt that could be done, but I think you are making it so complicated you are tying it up. I think the same thing could be accomplished by some member of the American Association moving that the president of the American Association do that. My idea is that we should receive this as a progress report, with the definite understanding that the matter will come up in the American Association.

C. L. HENRY:— I move that the report be received, and that the presidents of these two associations, who will be members of the incoming Executive Committee of the American Association be requested to call the attention of the Executive Committee of that Association to these recommendations.

(Motion duly seconded, stated and carried.)

PRESIDENT BRUSH:— It is fair to assume that each delegate has read this report, it being the intention of the Association that that should be the case, that being the reason for having these reports printed early and distributed. In view of that, it is entirely proper, under President Crecelius' jurisdiction, to have such discussion of this report as a whole as you now see fit.

(President Crecelius of the Engineering Association in the Chair.)

C. R. HARTE:— I do not know whether or no it comes properly before us at the present time, but certain facts in connection with this signal report make it seem desirable that

the Executive Committee or whoever has charge of these matters should suggest to all committees that drawings of the type shown here should be a little more specific. It appears there is at least a question as to whether the adoption of this design in a way blocks out all other types, or whether, as was doubtless the intent, it merely standardizes the base mechanism type of post, without in any way affecting other types. Particularly in the case of standards, drawings should conform to the fundamental requirement of good engineering, that they not only can be understood but that they cannot be misunderstood.

PRESIDENT CRECELIUS:— If there is no further discussion this terminates the joint meeting. A motion to receive the report as a whole is in order, expressing the appreciation of the Convention for the Committee's work.

C. R. HARTE:— I move, Mr. President, that we accept this report, and express the appreciation of the two Associations for the excellent work done by the Committee.

(Motion duly seconded, stated and carried.)

(The joint meeting of the Engineering and Transportation and Traffic Associations then adjourned.)

TUESDAY SESSION

OCTOBER 5, 1915

President Crecelius called the meeting to order at 3 o'clock P. M.

PRESIDENT CRECELIUS:— We will now take up one of the most important reports of our standing committees, the report of the Committee on Equipment, of which Mr. W. G. Gove is Chairman, and who will present the report.

W. G. GOVE:— In order to take up as little time as possible in the presentation of this report, and to expedite action on this report, I have prepared a written abstract, which I will read, to save our time, and will refer to the essential points in the report, without going into detail on the report as a whole. No doubt you have all read the report, as advance copies of it were distributed to the members before the meeting as well as at the meeting.

REPORT OF COMMITTEE ON EQUIPMENT

To the American Electric Railway Engineering Association:

GENTLEMEN.— At the meeting of your Executive Committee held in New York City November 10, 1914, the following subjects were adopted for investigation by the Committee on Equipment:

Subject (*a*) — Need for Revision of the Association's Standard Specification for Heat Treated Carbon Steel Axles, Shafts, and Similar Parts, adopted in 1912.

" (*b*) — Specifications for Gears and Pinions, including tolerances.

" (*c*) — M. C. B. Brass, Heavy Electric Traction.

" (*d*) — Wires and Cables for Car Equipment, with especial reference to Fire Protection.

" (*e*) — Specifications for Air Brake Hose.

" (*f*) — Limit of Wear Gauge for the Association's Standard Wheel Flange Thickness.

" (*g*) — Revision of Steel Wheel Design to include smaller diameters.

" (*h*) — Review all Existing Standards and Recommendations originating with the Committee on Equipment.

" (*i*) — Consideration of Standardization Rules of the American Institute of Electrical Engineers.

Immediately after the assignment of these subjects, your Committee was organized and the following sub-committees were appointed, with instructions to investigate and report upon the subjects as indicated:

Subject (*a*) — W. E. Johnson and R. H. Dalgleish.
" (*b*) — R. H. Dalgleish and J. R. Ayers.
" (*c*) — R. N. Hemming and L. M. Clark.
" (*d*) — W. R. McRae and F. W. Garrett.
" (*e*) — W. E. Johnson and W. R. McRae
" (*f*) — F. W. Garrett and W. E. Johnson.
" (*g*) — J. R. Ayers and F. R. Phillips.
" (*h*) — F. R. Phillips and R. H. Dalgleish.
" (*i*) — L. M. Clark and R. N. Hemming.

Unfortunately, Mr. J. R. Ayers was prevented, through illness, from continuing his work and accordingly tendered his resignation temporarily from the Committee. This was accepted with sincere regrets at the meeting of the Committee held in New York City on January 27, 1915, and Mr. W. E. Johnson was appointed to succeed him on Sub-Committee, Subject (*b*), and Mr. F. R. Phillips consented to continue alone on Subject (*g*).

Due to extreme conditions prevailing in Canada on account of the European war, Mr. W. R. McRae was also prevented from actively continuing in his work of the Committee. As the subject which he was investigating is a particularly important one (Wires and Cables for Car Equipment), and due to the short time in which to complete investigation and make report, it was deemed desirable to appoint some one to carry on the work of Mr. McRae on Sub-committee, Subject (*d*), who was familiar with the subject and who was in close touch with other organizations at that time actively engaged in its consideration. Mr. W. W. Brown was accordingly appointed to the Committee on Equipment by special appointment of the President of your Association to continue the work of Mr. McRae, particularly in connection with Subject (*d*).

The Members of the Committee on Equipment have been extremely active during the past year in the prosecution of the subjects assigned to them, and in addition to the regular assignments, a number of matters brought to our attention have been investigated, which are believed worthy of submitting for your consideration. These will be briefly outlined before presenting the formal recommendations in connection with the subjects assigned to the Committee.

REVISIONS OF STANDARD SPECIFICATIONS FOR HEAT-TREATED AND ANNEALED CARBON STEEL AXLES, SHAFTS, AND SIMILAR PARTS

The Sub-committee on Subject (*a*), who was assigned to investigate the need for revision of the Association's Standard Specifications for Heat-Treated Carbon Steel Axles, Shafts, and Similar Parts completed their investigation and reported their conclusions at meeting

of the Committee on Equipment held in New York City on January 27th, 1915; these conclusions are briefly outlined later in this report; their recommendations being adopted at that meeting with slight modification, the Sub-committee recommended in order that the revision of the Specifications be expedited, their assignment be extended to include the revision of the specifications during the present year along the lines approved by the Committee at that meeting; also that in view of the fact that the Association's Standard Specification for Annealed Carbon Steel Axles, Shafts, and Similar Parts, is so closely corelated to the specification under consideration, they include a revision of the annealed forging specification. These recommendations were approved by the Committee and the Sub-committee submitted revision of these specifications, which were duly approved at the last meeting, with slight modification, and recommended by the Committee for adoption as Standard Specifications in place of the present Specifications for Heat-Treated Carbon Steel Axles, Shafts, and Similar Parts, and Annealed Carbon Steel Axles, Shafts, and Similar Parts. The revised specifications will be found on pages 239 to 247.

PROOF TESTING OF FORGINGS TO DETERMINE THEIR SOUNDNESS AFTER QUENCHING AND TEMPERING

The Sub-committee investigating need for revision of Standard Specification for Heat Treated Carbon Steel Axles, Shafts, and Similar Parts, was instructed at meeting of January 27, 1915, to investigate the subject of Proof-Testing Forgings to determine their soundness after quenching and tempering, with a view toward recommending suggestion for purchaser's consideration in connection with the determination of proof-test required for this class of material. The Sub-committee corresponded with various steel makers and inspection bureaus relative to this matter, and also visited steel plants for the purpose of ascertaining facilities and requirements for such tests. This was also taken up for consideration at a meeting of the Sub-committee with the manufacturers' representatives and representative from the Committee on Heavy Electric Traction held in New York on April 15, 1915. Full report of Sub-committee on this matter is contained in Appendix **A**, and it is recommended that this be published in the Engineering Manual of the Association as a general guide for the test of axles and similar forgings.

SUB-COMMITTEE ON FLEXIBLE STRANDING OF THE STANDARDS COMMITTEE, A. I. E. E.

The Chairman of Sub-committee on Subject (*d*) was assigned to represent the Committee on Equipment on Sub-committee on Flexible Stranding of the Standards Committee of the American Institute of Electrical Engineers. A meeting of this Committee was held at Institute Headquarters on April 8th, 1915, when the matter of flexible

stranding was considered, with a view toward the adoption of the standard flexible cables.

The Sub-committee decided to recommend the abandonment of the term "Extra Flexible," and at least for the present have only one degree of flexibility above the present A. I. E. E. standard; this new grade to be known as "Flexible." A table of this new grade of flexible cables is appended (Appendix B), in order to ascertain whether it will meet with general approval, and in the hopes that suggestions will be submitted which may lead to their improvement. The Sub-committee also desires to ascertain if any additional degree of flexibility other than that indicated by this table will be necessary. It is hoped that Member Companies will indicate their views on the matter for the benefit of the Committee who is investigating this subject.

MEETINGS

Since the last Annual Convention, the Committee on Equipment has held two meetings, both at the Association headquarters in New York City, the first being held on Jan. 27, 1915, at which were present Messrs. Gove, Hemming, Johnson, Dalgleish, and Garrett, when preliminary reports on the progress of the work under consideration were submitted and discussed in detail, and further action recommended for the continuation of the work by the Sub-committees.

The final meeting was held on May 17, 1915, and attended by Messrs. Gove, Clark, Phillips, Johnson, Dalgleish, Brown and Garrett of the Committee, and Mr. R. C. Bird, representing the National Fire Protection Association, Electrical Committee, the latter only during the discussion in connection with Subject (*d*), Wires and Cables for Car Equipment, and who had been coöperating with the Sub-committee on this subject. At that meeting, the reports of the Sub-committees were received, carefully reviewed and corrected, and recommendations as given below adopted.

NEED FOR REVISION OF STANDARD SPECIFICATIONS FOR HEAT-TREATED CARBON STEEL AXLES, SHAFTS, AND SIMILAR PARTS

The present specifications were carefully reviewed by the Sub-committee, and a communication was addressed jointly to the representative manufacturers of this class of material, wherein certain features of the specifications, regarding which more or less comment had come to our attention, were specifically mentioned as requiring consideration in connection with proposed revision, and their full and frank opinions on the entire specifications solicited. This communication brought very favorable results in bringing out numerous criticisms and suggestions for a revision to conform to modern practice. After full and careful consideration of various comments brought out in connection with our present specifications, attention was called to the necessity for revision of various features of the specifications which, briefly summarized, are as follows:

1. TITLE:

The phrase "Heat-Treated" used in the title of the present specification, is a general term that could properly be applied to any other treatment, such as "Annealing", while the specification covers only material which is quenched and then tempered or "Drawn back." It was, therefore, suggested that in order to make the title specific in indicating class of material intended that the words "quenched" and "tempered" be substituted for "Heat-Treated." The substitution of the word "forgings" for "parts" was also suggested.

2. PROCESS OF MANUFACTURE:

This clause of the present specification is indefinite, in that it calls for open hearth or other approved process. It is proposed that this be changed so as to definitely call for open hearth process, unless otherwise specified.

3. CHEMICAL ANALYSES:

The Sub-committee recommended that provision should be made for ladle analysis to be furnished by the manufacturer and check analysis to be made, if desired, by purchaser from drillings or turnings of tensile test specimen.

4. PHYSICAL PROPERTIES:

Attention was called to desirability of dividing this grade of material into classes according to sizes, due to the effect of heat treatment and working of steel upon the physical properties. Attention was also called to the recent action of the A. S. T. M. in adopting a sliding scale for elongation and reduction in area, based on the inverse ratio of tensile strength. This phase of the specification has since been carefully considered, and the Sub-committee recommended that only minimum ductility requirements be specified, the same as in the present specification. While it has been claimed by certain manufacturing interests that the minimum of 22 per cent elongation and 45 per cent reduction in area are too high, requiring drastic heat treatment, the Sub-committee has been unable to find any conclusive evidence to this effect, and from examination of numerous test reports of this class of material of various sizes within the range covered by specification, we are convinced that the above minimum requirements are proper and entirely reasonable.

Attention was also called to the method prescribed in our present specifications for making tensile test, and we have recommended that this be modified, eliminating necessity for applying loads in increments.

5. SPECIMEN FOR TENSILE AND COLD BEND TEST:

The designation of treating lots of axles by "quenching charge" and "tempering charge", in line with A. S. T. M. specification, was suggested and also that provisions be made for specimens to be taken from any forging from each tempering charge, quenching charge, and melt. The present specification provides only for specimens for each

"Treating plant heat", regardless of the number of quenching charges represented in the tempering charge. The terms "tempering charge" and "quenching charge" have also been clearly defined.

6. HEAT TREATMENT:

Section on heat treatment has been modified in accordance with present accepted practice.

7. PROOF TEST:

Attention was called by the Sub-committee to the desirability of incorporating a proof test in specifications for this class of material. The Sub-committee was accordingly instructed to make investigation of this matter and thereupon report. This was covered in preliminary remarks and full report of the Sub-committee is contained in Appendix **A**, page 274.

8. RE-TREATING:

It is suggested that a limit be placed upon the number of times which forgings could be re-treated.

9. INSPECTION:

Attention is called to the fact that the present specification is somewhat conflicting, in that it requires "all tests and inspections to be made at place of manufacture prior to shipment and free of cost to purchaser," while the following sentence provides that the "purchaser shall have the right to make test to govern acceptance or rejection in his own testing room or elsewhere." The cost of such inspection would obviously fall upon the purchaser and, therefore, this conflicts with the previous requirements.

As stated in the preliminary remarks, the Sub-committee was instructed to proceed with the revision of specification incorporating these suggested changes; proposed revised specifications for both "quenched and tempered" and "annealed" material are given in full below.

PROPOSED REVISION OF STANDARD SPECIFICATION FOR HEAT-TREATED CARBON STEEL AXLES, SHAFTS, AND SIMILAR PARTS

(Recommended for Adoption as a Standard Specification Superseding that Adopted in 1911 — Eng. Man. Et 9a.)

SPECIFICATION FOR QUENCHED AND TEMPERED CARBON STEEL AXLES, SHAFTS, AND SIMILAR FORGINGS*

I MANUFACTURE

PROCESS:

1. Unless otherwise specified, the steel shall be made by the Open Hearth process.

DISCARD:

2. A sufficient discard shall be made from each ingot to secure freedom from injurious piping and undue segregation.

*Formally approved by both the Committee on Standards and the 1915 Convention as Standard.

PROLONGATIONS FOR TESTS:

3. Unless otherwise specified by the purchaser, a full size prolongation shall be left on each forging for test purposes.

HEAT TREATMENT:

4. (*a*) For quenching and tempering, the forgings shall be allowed to become cold after forging. They shall then be uniformly reheated to the proper temperature to refine the grain (a group thus reheated being known as a "quenching charge") and quenched in some medium, under substantially uniform conditions for each quenching charge. After quenching, they shall be uniformly reheated to the proper temperature for tempering or "drawing back" (a group thus reheated being known as a "tempering charge"), and allowed to cool uniformily.

(*b*) The variation in thickness or diameter of forging, as determined by the specified diameter or thickness which governs the size of prolongation from which the test specimens are taken, shall not exceed two (2) inches for forgings included in the same quenching or tempering charge.

TURNING:

5. (*a*) The forgings shall conform to sizes and shapes specified by the purchaser.

(*b*) Unless otherwise specified by the purchaser, axles, shafts, and similar round forgings, shall have a collar approximately two (2) inches in width left rough forged on each forging, and the remainder of forging shall be rough turned, with an allowance of one-eighth (⅛) inch on the surface for finishing.

(*c*) Unless otherwise specified, all axles, shafts, and similar forgings, shall have ends faced, with an allowance of one-eighth (⅛) inch on each end for finishing, and shall be centered for 60 deg. lathe centers, with clearance for points.

II Chemical Properties and Tests

CHEMICAL COMPOSITION:

6. The steel shall conform to the following limits in chemical composition:

Carbon	not over 0.60 per cent.
Manganese	0.40 to 0.80 per cent.
Phosphorus	not over 0.05 per cent.
Sulphur	not over 0.05 per cent.

LADLE ANALYSES:

7. An analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt, a copy of which shall be given to the purchaser or his representative. This analysis shall conform to the requirements specified in Section 6.

CHECK ANALYSIS:

8. (*a*) Analyses may be made by the purchaser from a forging representing each melt, which shall conform to the requirements specified in Section 6. Drillings for analysis may be taken from the forging, or from a full size prolongation of the same, at any point midway between the center and surface; or turnings from a tensile test specimen may be used.

(*b*) In addition to the complete analyses, a phosphorus determination may be made by the purchaser from turnings from each tensile test specimen, and this determination shall conform to the requirements for phosphorus specified in Section 6.

III. Physical Properties and Tests

TENSILE TESTS:

9. (*a*) After final treatment, the forgings shall conform to the following minimum tensile properties:

Size	Tensile strength lb. per sq. in.	Elastic limit lb. per sq. in.	Elongation in 2 in. Per cent.	Reduction of area. Per cent.
Up to 4-in. diameter or thickness.....	90,000	55,000	22	45
Over 4 in. up to 7 in. diameter or thickness.	85,000	50,000	22	45

(*b*) The classification by size shall be determined by the specified diameter or thickness of forging, which governs the size of the prolongation, from which the test specimens are taken.

(*c*) The elastic limit shall be determined by means of an extensometer.

BEND TESTS:

10. The bend test specimen shall bend cold through 180 deg. around a one (1) inch flat mandrel having a rounded edge of one-half (½) inch radius, without cracking on the outside of the bent portion.

PROOF TESTS:

11. Unless otherwise specified by the purchaser, each forging shall be subject to an impact proof test after heat treatment. The details of this test shall be agreed upon by the manufacturer and the purchaser.

LOCATION OF TEST SPECIMENS:

12. (*a*) Tension and bend test specimens shall be taken from a full size prolongation of any forging. The axis of the specimens shall be located at any point midway between the center and surface of forging and shall be parallel to the longitudinal axis of the forging.

(*b*) Tension test specimen shall be of the form and dimension shown in Fig. 1.

(*c*) Bend test specimen shall be one-half (½) inch square in section with corners rounded to a radius of not over one-thirty-second (1/32) inch and need not exceed six (6) inches in length.

NUMBER OF TESTS:

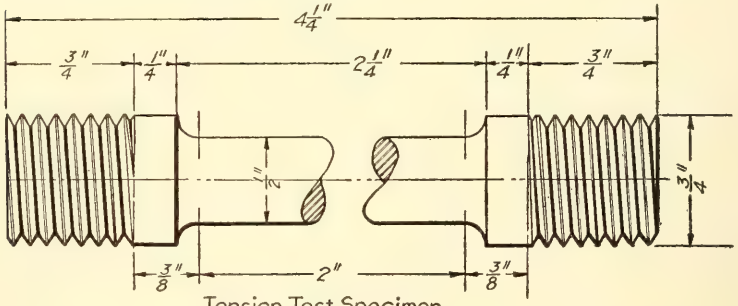
13. (*a*) One tension and one bend test shall be made from each tempering charge. If more than one quenching charge is represented in a tempering charge, one tension and one bend test shall be made from each quenching charge. If more than one melt is represented in a quenching charge, one tension and one bend test shall be made from each melt.

(*b*) If any test specimen shows defective machining or develops flaws, it may be replaced by another specimen.

(*c*) If the percentage of elongation of any tension test specimen is less than specified in Section 9 (*a*) when any part of the fracture is more than three-quarters (¾) inch from the center of the gauge length, as indicated by scribe scratches marked on the specimen before testing, a re-test will be allowed.

RE-TREATING:

14. If the physical properties of any test lot of forgings do not conform to requirements specified in Section 9 (*a*), the manufacturer may retemper or requench and temper such lot, but not more than three additional times, unless authorized by the purchaser, and retests shall be made as specified in Section 13 (*a*).



Tension Test Specimen
Fig. 1

IV. Finish

FINISH:

15. The forgings shall be free from injurious defects and shall have a workmanlike finish.

V. Marking

MARKING:

16. (*a*) Each billet shall be legibly stamped with an identification number representing melt, which shall be transferred to the final forging immediately after reduction of billet has been completed.

(*b*) Before treatment, each forging shall be stamped with a shop identification number. These shop numbers are to permit of identifying the forgings in each quenching and tempering charge, to determine the number of physical tests as required by Section 13 (*a*).

(*c*) The name or trade mark of the manufacturer, identification number, and inspector's mark, shall be legibly stamped on each finished forging in location indicated by the purchaser.

(*d*) The manufacturer shall report to the purchaser upon each shipment, the number of quenching and tempering charges, together with the melt numbers and identification numbers of forgings included in each quenching and tempering charge.

VI. Inspection and Rejection

INSPECTION:

17. (*a*) The entire process of manufacture of forgings shall be subject to purchaser's inspection, unless otherwise specified.

(*b*) The inspector representing the purchaser shall have free entry at all times, while purchaser's order or contract is being executed, to all parts of the manufacturer's works which concern the manufacture of forgings ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy the latter that forgings are being furnished in accordance with these specifications. Tests and inspection shall be made prior to shipment.

(*c*) The purchaser may make tests to govern the acceptance or rejection in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

(*d*) Unless otherwise agreed between the purchaser and the manufacturer, any rejection based on test made in accordance with Section 8 (*a-b*) shall be reported within ten working days from the receipt of samples.

(*e*) All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of work.

REJECTION:

18. Forgings represented by tests that fail to meet the foregoing requirements, or which prove defective on finishing, will be rejected and the manufacturer notified.

REHEARING:

19. Samples tested in accordance with Section 8 (*a-b*), which represents rejected material, shall be preserved for two weeks from the date of test report. In case of dissatisfaction with results of the tests, the manufacturer may make claim for a rehearing within that time.

PROPOSED REVISION OF RECOMMENDED SPECIFICATION FOR ANNEALED CARBON STEEL AXLES, SHAFTS, AND SIMILIAR PARTS

(Recommended for Adoption as a Standard Specification Superseding that Adopted in 1913 — Eng. Man. Et 11a.)

SPECIFICATION FOR ANNEALED CARBON STEEL AXLES, SHAFTS, AND SIMILAR FORGINGS*

I. Manufacture

PROCESS:

1. Unless otherwise specified, the steel shall be made by the Open Hearth process.

DISCARD:

2. A sufficient discard shall be made from each ingot to secure freedom from injurious piping and undue segregation.

PROLONGATIONS FOR TESTS:

3. Unless otherwise specified by the purchaser, a full size prolongation shall be left on each forging for test purposes.

HEAT TREATMENT:

4. (*a*) For annealing, the forgings shall be allowed to become cold after forging. They shall then be uniformly reheated to the proper temperature to refine the grain (a group thus reheated being known as an "annealing charge"), and allowed to cool uniformly.

TURNING:

5. (*a*) The forgings shall conform to sizes and shapes specified by the purchaser.

(*b*) Unless otherwise specified by the purchaser, axles, shafts, and similar round forgings, shall have a collar approximately two (2) inches in width left rough forged on each forging, and the remainder of forging shall be rough turned with an allowance of one-eighth (⅛) inch on the surface for finishing.

(*c*) Unless otherwise specified, all axles, shafts, and similar forgings, shall have ends faced, with an allowance of one-eighth (⅛) inch on each end for finishing, and shall be centered for 60 deg. lathe centers, with clearance for points.

II. Chemical Properties and Tests

CHEMICAL COMPOSITION:

6. The steel shall conform to the following limits in chemical composition:

Carbon	not over 0.60 per cent.
Manganese	0.40 to 0.70 per cent.
Phosphorus	not over 0.05 per cent.
Sulphur	not over 0.05 per cent.

*Formally approved by both the Committee on Standards and the 1915 Convention as Standard.

LADLE ANALYSES:

7. An analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt, a copy of which shall be given to the purchaser or his representative. This analysis shall conform to the requirements specified in Section 6.

CHECK ANALYSIS:

8. (*a*) Analyses may be made by the purchaser from a forging representing each melt, which shall conform to the requirements specified in Section 6. Drillings for analysis may be taken from the forging, or from a full size prolongation of the same, at any point midway between the center and surface; or turnings from a tensile test specimen may be used.

(*b*) In addition to the complete analysis, a phosphorus determination may be made by the purchaser from turnings from each tensile test specimen, and this determination shall conform to the requirements for phosphorus specified in Section 6.

III. Physical Properties and Tests

TENSILE TESTS:

9. (*a*) After annealing, the forgings shall conform to the following minimum tensile properties:

Tensile strength, lb. per sq. in.	80,000
Elastic limit, lb. per sq. in.	50 per cent. of tensile strength
Elongation in 2 in.	22 per cent.
Reduction in area	35 per cent.

(*b*) The elastic limit shall be determined by means of an extensometer.

BEND TESTS:

10. The bend test specimen shall bend cold through 180 deg. around a one (1) inch flat mandrel having a rounded edge of one-half (½) inch radius, without cracking on the outside of the bent portion.

LOCATION OF TEST SPECIMENS:

11. (*a*) Tension and bend test specimens shall be taken from a full size prolongation of any forging. The axis of the specimens shall be located at any point midway between the center and surface of forging and shall be parallel to the longitudinal axis of the forging.

(*b*) Tension test specimen shall be of the form and dimension shown in Fig. 1.

(*c*) Bend test specimen shall be one-half (½) inch square in section, with corners rounded to a radius of not over one-thirty-second (1/32) inch and need not exceed six (6) inches in length.

NUMBER OF TESTS:

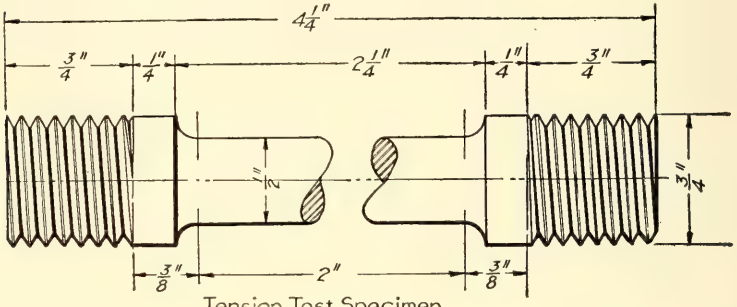
12. (*a*) One tension and one bend test shall be made from each annealing charge If more than one melt is represented in an annealing charge, one tension and one bend test shall be made from each melt.

(*b*) If any test specimen shows defective machining or develops flows, it may be replaced by another specimen.

(*c*) If the percentage of elongation of any tension test specimen is less than specified in Section 9 (*a*), when any part of the fracture is more than three-quarters (¾) inch from the center of the gauge length, as indicated by scribe scratches marked on the specimen before testing, a re-test will be allowed.

RE-TREATING:

13. If the physical properties of any test lot of forgings do not conform to requirements specified in Section 9 (*a*), the manufacturer may re-anneal such lot, but not more than three additional times, unless authorized by the purchaser, and re-tests shall be made as specified in Section 12 (*a*).



Tension Test Specimen
Fig. 1

IV. Finish

FINISH:

14. The forgings shall be free from injurious defects and shall have a workmanlike finish.

V. Marking

MARKING:

15. (*a*) Each billet shall be legibly stamped with an identification number representing melt, which shall be transferred to the final forging immediately after reduction of billet has been completed.

(*b*) Before annealing, each forging shall be stamped with a shop identification number. These shop numbers are to permit of identifying the forgings in each annealing charge, to determine the number of physical tests as required by Section 12 (*a*).

(*c*) The name or trade mark of the manufacturer, identification number, and inspector's mark, shall be legibly stamped on each finished forging in location indicated by the purchaser.

(*d*) The manufacturer shall report to the purchaser upon each shipment, the number of annealing charges, together with the melt numbers and identification numbers of forgings included in each annealing charge.

VI. Inspection and Rejection

INSPECTION:

16. (*a*) The entire process of manufacture of forgings shall be subject to purchaser's inspection, unless otherwise specified.

(*b*) The inspector representing the purchaser shall have free entry at all times, while purchaser's order or contract is being executed, to all parts of the manufacturer's works which concern the manufacture of forgings ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy the latter that forgings are being furnished in accordance with these specifications. Tests and inspection shall be made prior to shipment.

(*c*) The purchaser may make tests to govern the acceptance or rejection in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

(*d*) Unless otherwise agreed between the purchaser, and the manufacturer, any rejection based on test made in accordance with Section 8 (*a*) and (*b*) shall be reported within ten (10) working days from the receipt of samples.

(*e*) All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of work.

REJECTION:

17. Forgings represented by tests that fail to meet the foregoing requirements, or which prove defective on finishing, will be rejected and the manufacturer notified.

REHEARING:

18. Samples tested in accordance with Section 8 (*a*) and (*b*), which represents rejected material, shall be preserved for two weeks from the date of test report. In case of dissatisfaction with results of the tests, the manufacturer may make claim for a rehearing within that time.

SPECIFICATIONS FOR GEARS AND PINIONS

After a careful consideration on this subject, a preliminary specification was prepared and discussed at a meeting of the Sub-committee in New York on April 16, 1915, at which there were present: Messrs. W. H. Phillips, representing R. D. Nuttall Company, A. A. Ross, E. S. Schermerhorn, representing General Electric Co., E. S. Sawtelle, representing Tool Steel Gear & Pinion Co., H. Hegeman, representing U. S. Metal & Mfg. Co., W. E. Johnson, R. H. Dalgleish, representing the Sub-committee.

At this meeting several changes were suggested and the specifications were changed and submitted later to the manufacturers for their consideration.

The specifications submitted have been made as broad as possible in order not to impose any unnecessary hardship upon the manufacturer.

The Committee has prepared specifications for only two classes of material, "Case Hardened" and "Quenched and Tempered Forged Carbon Steel."

There are a number of other classes of material now being used and alloy steel is being developed for gears and pinions for railway service and should be encouraged by the Railway Companies. The Committee decided that as the "Case Hardened" and "Quenched and Tempered Carbon Steel" were the grades in more general use, it would be better not to try and cover too many grades owing to the rapid development in the gear and pinion treatment at the present time.

Your Committee recommends that each of these specifications be adopted as a Recommended Specification.

The full text of the specification follows:

SPECIFICATION FOR CASE HARDENED FORGED STEEL GEARS

(Recommended for Adoption as a Recommended Specification*)

I. Manufacture

MATERIAL:

1. All blanks for gears shall be made from open hearth steel which has been thoroughly worked to secure a homogeneous dense material, free from all injurious defects.

II. Chemical Properties and Tests

CHEMICAL PROPERTIES:

2. The steel shall conform to the following requirements as to chemical composition.

Carbon	0.12 to .28 per cent
Manganese	0.40 to .60 per cent
Phosphorus	not over .05 per cent
Sulphur	not over .05 per cent

CHECK ANALYSIS:

3. A check analysis may be made by the purchaser or his representative from one or more gear blanks from each lot of 100 or fraction thereof ordered and this analysis shall conform to the requirements specified above. Sample for check analysis to be taken at the pitch line so that the blank will not be destroyed.

III. Physical Properties and Tests

HARDNESS:

4. The hardness as shown by the scleriscope shall not be less than 80, taken at the top of the tooth after treatment.

TREATMENT:

5. All gears, after the teeth are cut, shall be carbonised to a depth approximately one-sixth of the thickness of the teeth on the pitch line.

*Formally approved by both the Committee on Standards and the 1915 Convention as a Recommendation.

IV. Finish

DIMENSIONS:

6. (*a*) The outside diameter over the teeth as machined, must not vary from that specified more than plus zero (0) inch or minus one-thirty-second (1/32) inch.

(*b*) The face of the gears must not vary from the specified width by more than plus one-thirty-second (1/32) inch or minus one-thirty-second (1/32) inch.

(*c*) The minimum thickness of the rim under the teeth shall be as follows, measured one-eighth (⅛″) inch from the edge of the rim.

Pitch	*Thickness of Rim*
3	⅜ in.
2½	7/16 in.
2	½ in.

WEB:

7. The web of all gears shall have four two (2) inch holes equally pitched in center of webbed section, unless otherwise specified.

BORE:

8. (*a*) The diameter of finished bore shall not vary from that specified by more than plus or minus .001 in.

(*b*) The diameter of rough bore shall not vary by more than one-sixteenth (1/16) inch over or one-eighth (⅛) inch under that specified.

(*c*) The ends of finished bores shall be chamfered one-sixteenth (1/16) inch to avoid injury to shaft when mounting.

(*d*) Bores shall be measured with pin gauge or inside micrometer.

HUB:

9. (*a*) The face of the hub to have a smooth bearing finish and run true with bore.

(*b*) The variation from the specified dimensions of hub and hub extension shall not exceed the following:

Length of hub over all, plus 0 to minus .03 inch.
Length of hub extension, plus 0 inch to minus 0.02 inch.
Diameter of hub extension, plus 0 inch to minus .03 inch.

KEYWAY:

10. (*a*) Where keyways are specified, the sides of the keyway shall be parallel with the axis of the bore, with a variation not to exceed six thousandths (0.006) inch in the total length of the keyway.

(*b*) The width of the keyway shall not vary from that specified by more than plus zero (0) inch or minus two thousandths (0.002) inch.

(*c*) The depth of the keyway shall not vary from that specified by more than plus one-sixty-fourth (1/64) inch or minus zero (0).

(*d*) The fillet at the bottom of the keyway shall have a one-sixteenth (1/16) inch radius.

TEETH:

11. (*a*) The thickness of the teeth at the pitch line must not be more than one hundredth (0.01) inch under the size specified, to allow for backlash, or plus zero (0) inch.

(*b*) The teeth shall be of the Brown & Sharpe standard 14½° degree involute form unless otherwise specified.

V. Marking

MARKING:

12. All gears shall be plainly stamped on motor side of rim as follows:

Grade .....

Month, year, serial number of manufacturer, consecutive for each month.

Name or initials of manufacturer.

VI. Inspection and Rejection

INSPECTION:

13. (*a*) All gears shall be tested for smooth running. The teeth must be equally spaced so that the gear will run smoothly in both directions with a master pinion.

(*b*) Records of all chemical analysis and physical tests shall be kept by the manufacturer and shall be available to the purchaser.

REJECTION:

14. The purchaser reserves the right to reject any portion of or all of the material which does not conform to the above specifications in every particular.

REPLACEMENT:

15. The manufacturer shall replace free of charge any gear sold, delivered or manufactured under this specification that may at any time prove defective in material or workmanship.

SPECIFICATION FOR QUENCHED AND TEMPERED FORGED CARBON STEEL GEARS

(Recommended for Adoption as a Recommended Specification*)

I. Manufacture

MATERIAL:

All blanks for gears shall be made from open hearth steel which has been thoroughly worked to secure a homogeneous dense material, free from all injurious defects.

*Formally approved by both the Committee on Standards and the 1915 Convention as a Recommendation.

II. Chemical Properties and Tests

CHEMICAL PROPERTIES:

2. The steel shall conform to the following requirements as to chemical composition:

Phosphorus.....not over 0.05 per cent
Sulphur.....not over 0.05 per cent

CHECK ANALYSIS:

3. A check analysis may be made by the purchaser or his representative from one or more gear blanks from each lot of 100 or fraction thereof ordered and this analysis shall conform to the requirements specified above. The sample for check analysis to be taken at the pitch line so that the blank will not be destroyed.

III. Physical Properties and Tests

PHYSICAL PROPERTIES:

4. (*a*) The physical properties to be obtained from a test piece machined from the gear at the base of the tooth in such a way as to represent the physical properties of the teeth when removed from service on account of wear.

(*b*) This specification to cover three grades of material, to be known as Grade 1, Grade 2 and Grade 3.

(*c*) The physical properties of each grade as shown by the test piece shall be as follows:

Minimum Physical Values for	Grade 1	Grade 2	Grade 3
Tensile strength (per sq. in.)	110,000	140,000	115,000
Elastic limit (per sq. in.)	80,000	130,000	80,000
Elongation in 2 in. (per cent.)	13	2	8
Reduction in area (per cent.)	30	6	25
Brinell hardness factor	300	460	418

TREATMENT:

5. (*a*) All gears, after the teeth are cut, shall be quenched to obtain hardness and then so drawn as to give toughness.

(*b*) The treatment as a whole shall be such as will leave the material practically free from distortion or internal stresses.

IV. Finish

DIAMETER:

6. The out side diameter over the teeth, as machined, must not vary from that specified by more than plus 0 inch or minus one-thirty-second (1/32) inch.

FACE:

7. (*a*) The face of the gears must not vary from the specified width by more than plus one-thirty-second (1/32) inch or minus one-thirty-second (1/32) inch.

(*b*) The minimum thickness of the rim under the teeth shall be as follows, measured one-eighth (⅛) inch in from the edge of the rim:

Pitch	*Thickness of Rim*
3	⅝ in.
2½	7/16 in.
2	½ in.

WEB:

8. The web of all gears shall have four two (2) inch holes equally pitched in center of webbed section, unless otherwise specified.

BORE:

9. (*a*) The diameter of finished bores shall not vary from that specified by more than plus or minus .001 inch.

(*b*) The diameter of rough bore shall not vary by more than one-sixteenth (1/16) inch over or one-eighth (⅛) inch under that specified.

(*c*) The ends of finished bores shall be chamfered one-sixteenth (1/16) inch to avoid injury to shaft when mounting.

(*d*) Diameter of bores shall be measured with pin gauge or inside micrometer.

HUB:

10. (*a*) The face of hub to have a smooth bearing finish and run true with bore.

(*b*) The variation from the specified dimensions of hub and hub extension shall not exceed the following:

Length of hub over all, plus 0 inch to minus .02 inch
Length of hub extension, plus 0 inch to minus 0.02 inch.
Diameter of hub extension, plus 0 inch to minus .03 inch.

KEYWAY:

11. (*a*) Where keyway is specified the sides of the keyway shall be parallel with the axis of the bore with a variation not to exceed six thousandths (0.006) inch in the total length of the keyway.

(*b*) The width of the keyway shall not vary from that specified by more than plus zero (0) inch or minus two thousandths (0.002) inch.

(*c*) The depth of keyway must not vary from that specified by more than plus one-sixty-fourth (1/64) inch or minus zero (0) inch.

(*d*) The fillet at the bottom of the keyway have a one-sixteenth (1/16) inch radius.

TEETH:

12. (*a*) The thickness of teeth at the pitch line must not be more than .01 inch under the size specified, to allow for backlash, or plus 0 inch.

(*b*) The teeth shall be of the Brown & Sharpe standard 14½ deg. involute form unless otherwise specified.

V. Marking

MARKING:

13. All gears shall be plainly stamped on motor side of rim as follows:

Grade .....

Month, year, serial number of manufacturer (consecutive for each year).

Name or initials of manufacturer.

VI. Inspection and Rejection

INSPECTION:

14. (*a*) All gears shall be tested for smooth running. The teeth must be equally spaced so that the gear will run smoothly in both directions with a master pinion.

(*b*) Records of all chemical analyses and physical tests shall be kept by manufacturer and shall be available to the purchaser.

REJECTION:

15. The purchaser reserves the right to reject any portion or all of the material which does not conform to the above specification in every particular.

REPLACEMENT:

16. The manufacturer shall replace free of charge any gear sold, delivered or manufactured under this specification that may at any time prove defective in either material or workmanship.

SPECIFICATION FOR CASE HARDENED FORGED STEEL PINIONS

(Recommended for Adoption as a Recommended Specification*)

I. Manufacture

MATERIAL:

1. This specification to cover two classes of material, determined as follows:

Class 1: Each pinion shall be made from individual blanks of open hearth steel which has been thoroughly worked to secure a homogeneous dense material, free from all injurious defects.

Class 2: Each pinion shall be made from forged bars of open hearth steel, hammered or pressed to secure a homogeneous dense material, free from all injurious defects.

II. Chemical Properties and Tests

CHEMICAL PROPERTIES:

2. The steel shall conform to the following requirements as to chemical composition:

Carbon	0.12 to .28 per cent.
Manganese	0.40 to .60 per cent.
Phosphorus	not over .05 per cent.
Sulphur	not over .05 per cent.

*Formally approved by both the Committee on Standards and the 1915 Convention as a Recommendation.

CHECK ANALYSIS:

3. A check analysis may be made by the purchaser or his representative from one or more pinion blanks from each lot of 100 or fraction thereof ordered, and this analysis shall conform to the requirements specified above. The sample for check analysis to be taken at the pitch line so that the blank will not be destroyed.

III. Physical Properties and Tests

HARDNESS:

4. The hardness as shown by the scleriscope shall not be less than 80, taken at the top of the tooth after treatment.

TREATMENT:

5. All pinions, after the teeth are cut, shall be carbonized to a depth approximately one-sixth (1/6) of the thickness of the tooth on the pitch line.

IV. Dimensions

DIAMETER:

6. The outside diameter of the pinion must not vary from that specified by more than plus zero (0) inch or minus one-thirty-second (1/32) inch.

FACE:

7. The face of the pinion must not vary from the specified width by more than plus or minus one-thirty-second (1/32) inch.

BORE:

8. All bores must be finished after treatment. The diameter of the bore must be such that the standard plug gauge will not project less than one-thirty-second (1/32) inch or more than three-thirty-seconds (3/32) inch measured at the large end of bore, and have bearing the full length of bore. All bores must be central with the pitch circle. All bores must have a reasonably smooth finish.

COUNTERBORE:

9. (*a*) The depth of the counterbore must not vary from that specified by more than plus zero (0) inch or minus one-thirty-second (1/32) inch.

(*b*) The diameter of the counterbore must not vary from that specified by more than plus one-thirty-second (1/32) inch or minus zero (0) inch.

KEYWAY:

10. (*a*) The sides of the keyway must be cut parallel with the center line of the pinion.

(*b*) The width of the keyway must not vary from that specified by more than plus three thousandths (.003) inch or minus zero (0) inch.

(*c*) The depth of the keyway must not vary from that specified by more than plus one-sixty-fourth (1/64) inch or minus zero (0) inch.

(*d*) The fillet at the bottom of the keyway shall have one-thirty-second (1/32) inch radius for widths up to seven-eighths (7/8) inch inclusive, and one-sixteenth (1/16) inch radius for widths over seven-eighths (7/8) inch. With this specification one-thirty-second (1/32) inch clearance shall be provided for widths up to seven-eighths (7/8) inch and one-sixteenth (1/16) inch clearance for widths over seven-eighths (7/8) inch.

TEETH:

10. (*a*) The thickness of teeth at pitch line must not be more than plus zero (0) inch or minus one-hundredth (.01) inch of specified thickness.

(*b*) The teeth shall be of Brown and Sharpe standard 14½ deg. involute form unless otherwise specified.

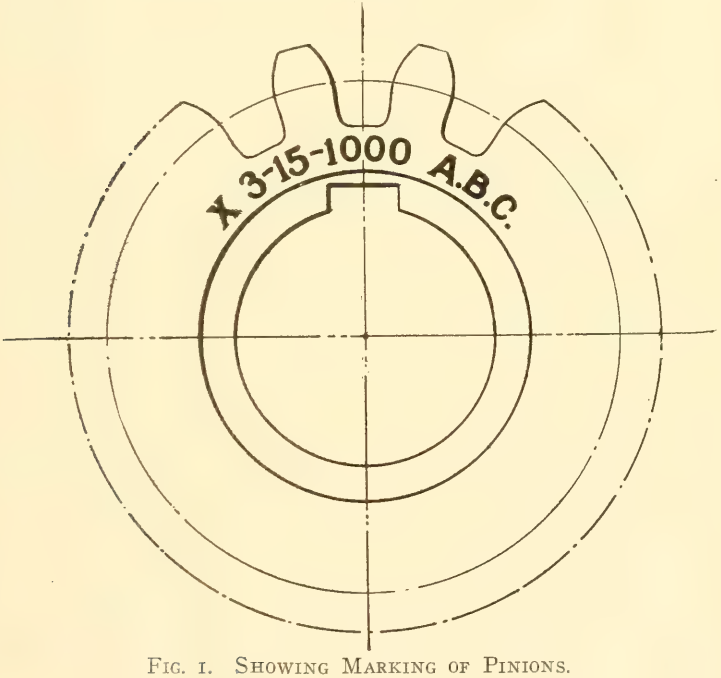


FIG. 1. SHOWING MARKING OF PINIONS.

V. MARKING

MARKING:

11. All pinions shall be plainly stamped, preferably on the outer end with steel letters approximately ¼ inch as follows:

Grade .....
Month, Year.
Manufacturer's serial number (to be consecutive for each month).
Name, initials or trademark of manufacturer.

VI. Workmanship and Finish

FINISH:

12. (*a*) All pinions shall be tested for smooth running. The teeth must be equally spaced so that they will run smoothly in both directions with a master gear.

(*b*) All pinions shall be gauged with a standard taper plug gauge which shall be the same size as the nominal size of the bore at the large end.

VII. Inspection and Rejection

INSPECTION:

13. All pinions shall be free from any seams, cracks, or other defects that would in any way affect their service.

REJECTION:

14. The purchaser reserves the right to reject any portion of or all of the material which does not conform to the above specification in every particular.

REPLACEMENT:

15. The manufacturer shall replace free of charge any pinion sold, delivered and manufactured under this specification that may at any time prove defective in either material or workmanship.

SPECIFICATION FOR QUENCHED AND TEMPERED FORGED CARBON STEEL PINIONS

(Recommended for Adoption as a Recommended Specification*)

I. Manufactured

MATERIAL:

1. All pinions shall be made from individual blanks of open hearth steel which has been thoroughly worked to secure a homogeneous dense material free from all injurious defects.

II. Chemical Properties and Tests

CHEMICAL PROPERTIES:

2. The steel shall conform to the following requirements as to chemical composition:

Phosphorus	not over 0.05 per cent.
Sulphur	not over 0.05 per cent.

CHECK ANALYSIS:

3. A check analysis may be made by the purchaser or his representative from one or more pinion blanks from each lot of 100 or fraction thereof ordered, and this analysis shall conform to the requirements specified above. The sample for check analysis to be taken at the pitch line so that the blank will not be destroyed.

*Formally approved by both the Committee on Standards and the 1915 Convention as a Recommendation.

III. Physical Properties and Tests

PHYSICAL PROPERTIES:

4. (*a*) The physical properties to be obtained from a test piece machined from the pinion at the base of the tooth in such a way as to represent the physical properties of the tooth when removed from service on account of wear.

(*b*) This specification to cover three grades of material, to be known as Grade 1, Grade 2, and Grade 3.

(*c*) The physical properties of each grade as shown by the test piece shall be as follows:

Minimum Physical Values for	Grade 1	Grade 2	Grade 3
Tensile Strength (per sq. in.)	110,000	140,000	115,000
Elastic Limit (per sq. in.)	80,000	130,000	80,000
Elongation in 2 in. (per cent)	13	2	8
Reduction in area in 2 in (per cent)	30	6	25
Brinnell Hardness Factor	300	460	418

TREATMENT:

5. (*a*) All pinions after the teeth are cut shall be quenched to obtain hardness and then so drawn as to give toughness.

(*b*) The treatment shall be such as will leave the material practically free from distortion or internal stresses.

TESTS:

6. (*a*) A sample pinion for tests may be selected by the purchaser or his representative from each lot of one hundred or fraction thereof if less are ordered. The standard turned test piece one-half (½) inch diameter by two (2) inch gauge length shall be taken from sample pinion as provided under section 4(*a*).

(*b*) The Manufacturer shall make one Brinnell hardness test at the top of a tooth at the center of the face of each finished pinion.

(*c*) The Brinnell hardness factor shall conform to that specified under section 4(*c*).

IV. Dimensions

DIAMETER:

7. The outside diameter of the pinion must not vary from that specified by more than plus zero (0) inch or minus one-thirty-second (1/32) inch, measured at the center of the face.

FACE:

8. The face of the pinion must not vary from the specified width by more than plus or minus one-thirty-second (1/32) inch.

BORE:

9. (*a*) All bores must be finished after treatment. The diameter of the bore must be such that the standard plug gauge will not project

less than one-thirty-second (1/32) inch or more than three-thirty-seconds (3/32) inch measured at the large end of bore, and have bearing the full length of bore.

(*b*) All bores must be central with the pitch circle. All bores must have a reasonably smooth finish.

COUNTERBORE:

10. (*a*) The depth of the counterbore must not vary from that specified by more than plus zero (0) inch or minus one-thirty-second (1/32) inch.

(*b*) The diameter of the counterbore must not vary from that specified by more than plus one-thirty-second (1/32) inch or minus zero (0) inch.

KEYWAY:

11. (*a*) The sides of the keyway must be cut parallel with the center-line of the pinion.

(*b*) The width of the keyway must not vary from that specified by more than plus three-thousandths (.003) inch or minus zero (0) inch.

(*c*) The depth of the keyway must not vary from that specified more than plus one-sixty-fourth (1/64) inch or minus zero (0) inch.

(*d*) The fillet at the bottom of the keyway shall have one-thirty-second (1/32) inch radius for widths up to seven-eighths (7/8) inch inclusive, and one-sixteenth (1/16) inch radius for widths over seven-eighths (7/8) inch. With this specification one-thirty-second (1/32) inch clearance shall be provided, for widths up to seven-eighths (7/8) inch and one-sixteenth (1/16) inch clearance for widths over seven-eighths (7/8) inch.

TEETH:

12. (*a*) The thickness of teeth at pitch line must not be more than plus zero (0) inch or minus one-hundreth (.01) inch of specified thickness.

(*b*) The teeth shall be of Brown and Sharpe standard 14½ deg. involute form unless otherwise specified.

V. Marking

MARKING:

13. All pinions shall be plainly stamped, preferably on the outer end, with steel letters approximately one-quarter (¼) inch as follows:

Grade .....
Month, Year.
Manufacturer's serial number (to be consecutive for each month).
Name, initials or trademark of manufacturer.

VI. Workmanship and Finish

WORKMANSHIP AND FINISH:

14. (*a*) All pinions shall be tested for smooth running. The teeth must be equally spaced so that they will run smoothly in both directions with a master gear.

(*b*) All pinions shall be gauged with a standard taper plug gauge, which shall be the same size as the nominal size of the bore at the large end.

(*c*) This plug gauge must project not less than one-thirty-second (1/32) inch or more than three-thirty-seconds (3/32) inch as specified under Section 9(*a*).

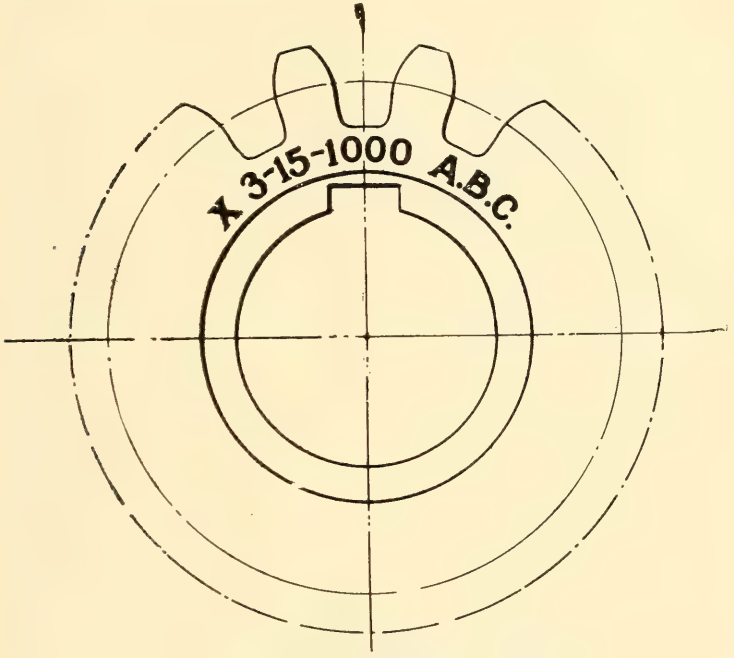


FIG. 1. SHOWING MARKING OF PINIONS

VII. INSPECTION AND REJECTION

INSPECTION:

15. All pinions shall be free from any seams, cracks, or other defects that would in any way affect their service.

REJECTION:

16. The purchaser reserves the right to reject any portion of or all of the material which does not conform to the above specifications in every particular.

REPLACEMENT:

17. The manufacturer shall replace free of charge any pinion sold, delivered or manufactured under this specification that may at any time prove defective in either material or workmanship.

M. C. B. BRASS FOR HEAVY ELECTRIC TRACTION

The numerous details involved in the consideration of this subject has made it impossible for the Committee to entirely complete its investigation and make a definite recommendation during the present year. A great deal of work has been accomplished which will be of value in the future consideration of this subject, and it is recommended that this be continued for investigation by the ensuing Committee.

WIRES AND CABLES FOR CAR EQUIPMENT

This subject is of long standing, having been under investigation for several years, and was assigned to the Committee on Equipment for the present year for further consideration, with especial reference to fire protection for both 600 and 1200 volt equipments. Your Executive Committee particularly requested that we confer with Committee of the National Fire Protection Association on this matter, and especially on the use of lighter conduits in car roofs. Unfortunately, the work of this Sub-committee was somewhat delayed at the beginning, due to the Chairman being unable to devote more of his time to it on account of conditions prevailing in Canada, due to the European war. In view of the importance of this matter, however, it was felt that rather than allow it to continue for another year without definite action and coöperation with the National Fire Protection Association, it was desirable to appoint someone in Mr. McRae's place and who could give the necessary time to carry it to completion. Accordingly, Mr. W. W. Brown was appointed to succeed Mr. McRae as Chairman of Sub-committee, Subject (*d*), and as the time subsequent to this appointment was somewhat limited, the Sub-committee gave especial consideration to the subject of Car Wiring and coöperated with other Committees investigating this subject, from the viewpoint of providing proper protection against fires, with a view toward the adoption of such rules which, if followed, would give adequate fire protection and would also ensure reliability of equipment. Two conferences were held with Mr. R. C. Bird as representing the Electrical Committee of the N. F. P. A. At these conferences, discussion was had on the revision of the rules for car wiring and equipment of cars as contained in Section 40 of the National Electrical Code, Edition of 1913. Prior to the writing of the tentative draft covering the revision of these rules, a meeting of representatives of Car Builders, Electrical Equipment Manufacturers, Fire Underwriters organizations, Consulting Engineers, and Electric Railway Companies, was called at the suggestion of Mr. W. H. Heulings of the J. G. Brill Company, for the purpose of considering the same subject on which our Sub-committee was working. The Chairman of the Sub-committee attended this meeting, which was held at 84 William Street, New York City, April 20th, 1915, at 10 a. m. At that meeting a Committee was appointed to consider the revision of the Code Rules of the N. F. P. A.

and that Committee was instructed to confer with our Sub-committee on Subject (*d*), and also with the Sub-committee of the Electrical Committee of the National Fire Protection Association. Meetings of that Committee were held on April 20th, 26th, and 27th, 1915. The Chairman of your Sub-committee was present at the meetings of April 20th and 26th, 1915. As a result of those conferences and the discussion that was had, it was proposed that the Code Rules on Car Wiring be revised as shown in full in Appendix **C**. We have been informally advised by representative of the Electrical Committee of the National Fire Protection Association that that Association will immediately promulgate these proposed rules if approved by the American Electric Railway Engineering Association. It is, therefore, essential that each of these rules be carefully considered before adoption, and in connection with this, your Sub-committee, when conferring with the other Committees on the revision of these rules, considered the subject from the broad viewpoint of what would be best for potection against fire, and at the same time could be economically applied to existing equipment by all Railway Companies comprising the Membership of the American Electric Railway Association.

Consideration was also given to the question from the standpoint of efficiency and reliability of service where some of the Member Companies operating in the larger cities throughout the country can and must expend certain sums of money to obtain the reliability of service demanded in cities where slight delays would cause inconvenience to thousands of passengers, while on some of the smaller properties, where this reliability in service would not be such an absolute necessity and less expensive installation of electrical equipment might be made, but would be one that would be just as safe, from the fire hazard standpoint. There is no doubt that there are a great many of the existing cars and equipment now owned and operated by the Member Companies that do not meet the specified conditions and requirements of these proposed revised rules. We believe, however, that such cars in the majority of cases can be placed in such condition as to meet these requirements without a large expenditure. Whether the amount that would have to be thus expended would compensate for the reduction in the amounts expended yearly in penalties on insurance rates, is a question that must necessarily be determined by the management of each individual operating company.

The proposed rules are printed as an appendix of this report, in the hopes that this important subject will be carefully considered by the Member Companies, and that they will be discussed freely at the next Convention, or where, in case it will be impossible for the members to attend, that written discussion will be submitted. We recommend that the revised rules for Car Wiring and Equipment of Cars as proposed by the N. F. P. A. Electrical Committee, as a result

of the various conferences of interests affected and referred to in the foregoing, be printed in the Year Book of our Association and included in the Engineering Manual under the heading of "Miscellaneous Methods and Practices", and we further recommend that this subject be continued for investigation until the adoption of rules satisfactory to our Association.

SPECIFICATION FOR AIR BRAKE HOSE

We were instructed by the Executive Committee to review the Specification for Air Brake Hose adopted as a Recommended Specification by the 1913–14 Convention, with a view toward broadening same and including some of the smaller sizes commonly used in light electric railway service, also to give the matter of oil resisting inner tube further consideration for service where the hose is subject to drainage from motor driven compressor. The Sub-committee reports that upon their investigation into the matter of sizes, they found that the standard air brake equipment for city service as now being manufactured is arranged for ¾ in. interior diameter of hose, the ½ in. size formerly used as a standard being no longer supplied with new equipment, unless specifically called for by the purchaser. The ¾ in. size of hose should, therefore, be substituted for the ⅞ in. nominal size covered in the present specification; in view of this being the smallest size now recognized by the air brake companies, it is not deemed advisable to include smaller sizes in the specification.

In reviewing the present specification, several minor details have been brought to the attention of your Committee, and these are included in a revised specification appended hereto.

In Section 1 (*a*) four-ply hose is specified. It has been pointed out that with the ¾ in. size of hose, three-ply will provide ample strength and give greater flexibility. The revised specification accordingly includes three-ply hose for the ¾ in. size. Corrections have been made throughout the specification for the ¾ in. size hose in place of the ⅞ in. hose wherever this appears.

Stretching test has been modified to provide for shorter test piece from tube of ¾ in. size of hose, it being impossible to obtain the standard 2 in. stretch from a tube of this size.

In specifying three-ply hose for the ¾ in. size, the bursting pressure has been reduced to 600 lb., or the same as for the 1⅛ in. size.

A shorter tension test specimen for rubber has been included as the standard specimen could not be cut from the smaller size of hose.

Some of the members of your Committee have obtained a quantity of hose made in accordance with proposed specifications, also quantity of hose including oil resisting tube for the purpose of obtaining comparison. Results from trial of this hose should be available for the use of future Committees investigating this subject. We recommend

that the revised specification be adopted as a Recommended Specification. Full text of this specification appears below.

REVISED SPECIFICATION FOR AIR BRAKE HOSE

(Recommended for Adoption as a Recommended Specification to Supersede Present Specification Adopted in 1914*)

I. Manufacture

NUMBER OF PLY:

1. The hose shall be not less than four (4) ply for the one and one-eighth (1⅛) inch and one and three-eights (1⅜) inch size, and not less than three (3) ply for the three-quarter (¾) inch size, and shall be soft and pliable.

GRADE OF MATERIAL:

2. Only a high grade quality of rubber and cotton fabric shall be used. Rubber substitutes or short fibre cotton will not be acceptable.

SAMPLE FOR TESTS:

3. The manufacturer shall furnish, free of cost, one extra hose for test purposes, with each lot of two hundred (200) hose ordered.

II. Physical Properties and Tests

POROSITY TEST:

4. (*a*) For the purpose of determining the porosity of the inner tube, one hose will be selected at random from each lot of two hundred (200) ordered, and subjected to an air pressure of one hundred forty (140) pounds per square inch for a period of five (5) minutes. At the end of this time the rubber cover will be split with a knife and the hose submerged in water.

(*b*) Under this condition and with above air pressure still in the hose, the inner tube shall not show any porosity.

(*c*) Any escape of air must be distinct enough so as to permit of readily distinguishing between that due to the air which may be confined within the structure of the hose and that due to the porosity of the inner tube.

BURSTING TEST:

5. (*a*) One hose will be selected from each lot of two hundred (200) ordered and a section five (5) inches long cut from one end. The remainder of hose will then be subjected to a hydraulic pressure of two hundred (200) pounds per square inch, and under this pressure

*Formally approved by both the Committee on Standards and the 1915 Convention as a Recommendation.

the hose shall not show any signs of leakage nor develop any defects and shall meet the following requirements:

(*b*) The maximum expansion on the circumference shall not exceed the following:

Nominal size of hose	3/4 in.	1 1/8 in.	1 3/8 in.
Maximum expansion	1/2 in.	5/8 in.	3/4 in.

(*c*) The hose must then withstand the following hydraulic pressures for a period of ten (10) minutes.

Nominal size of hose	3/4 in.	1 1/8 in.	1 3/8 in.
Pressure, lb. per sq. in.	600	600	500

FRICTION TEST:

6. A section one (1) inch long will be taken from the five (5) inch section previously cut off, and a twenty (20) pound weight suspended from a separated end of wrapper in such a manner that the force will be applied radially and uniformly, and the amount of unwinding under these conditions shall not exceed eight (8) inches in ten (10) minutes.

STRETCHING TEST:

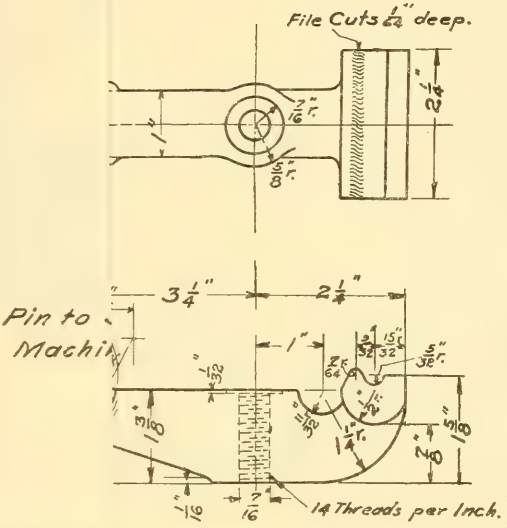
7. (*a*) Another section one (1) inch long will be cut from the remainder of the five (5) inch piece, and the rubber tube or lining will be separated from the ply, and cut at the lap, and tested as follows:

For tube and cover 1⅛ in. and 1⅜ in. hose and for cover of ¾ in. hose:

(*b*) Marks will be placed on this section two (2) inches apart and then the section will be quickly stretched until the marks are ten (10) inches apart and immediately released. The section will then be remarked as at first and again stretched to ten (10) inches and held in this position for a period of ten (10) minutes. It will then be released and when measured within thirty (30) seconds of the time of releasing the distance between the marks last applied shall not exceed two and one-quarter (2¼) inches. At the end of ten (10) minutes the distance between the marks will be again measured and the set at that time shall not exceed one-eighth (⅛) inch.

For tube of ¾ in. hose:

(*c*) Marks will be placed on this section one (1) inch apart and then the section will be quickly stretched until the marks are five (5) inches apart and immediately released. The section will then be remarked as at first and again stretched to five (5) inches and held in this position for a period of ten (10) minutes. It will then be released and when measured within thirty (30) seconds of the time of releasing the distance between the marks last applied shall not exceed one and one-eighth (1⅛) inches. At the end of ten (10) minutes the distance between the marks will be again measured and the set at that time shall not exceed one sixteenth (1/16) inch.



Pin to
Machi

One Required per Set
Material - Brass.
finish all over.

14th

Mat.

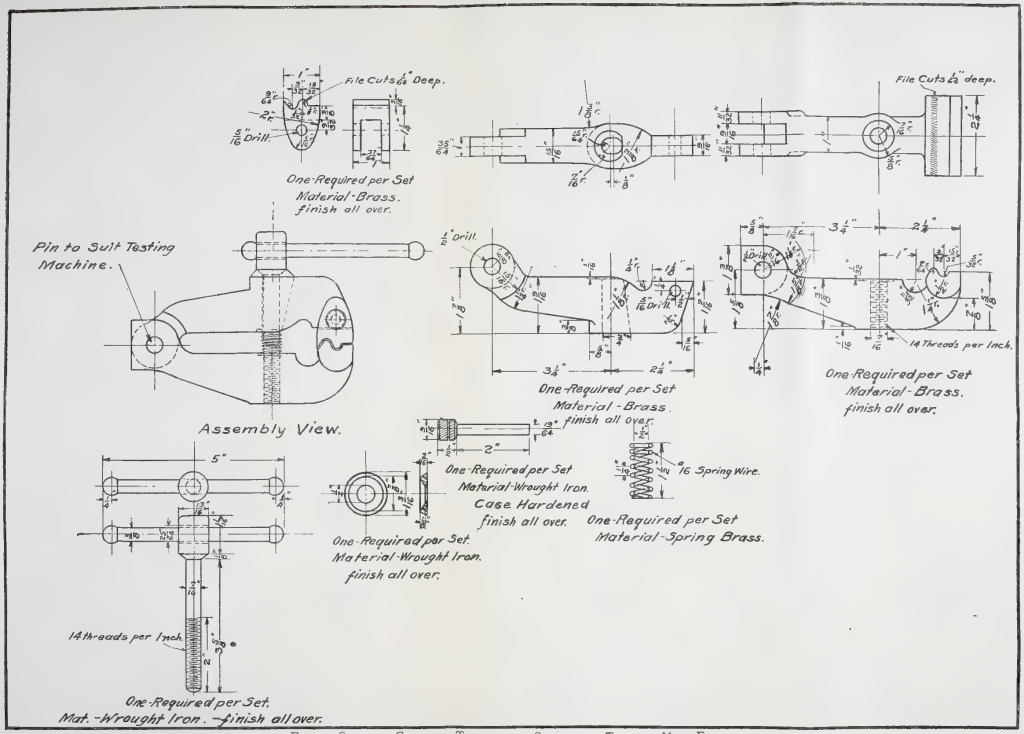


FIG. 1. SHOWING GRIPS FOR TENSILE AND STRETCHING TESTS OF HOSE FABRIC.

TENSION TEST:

8. (*a*) The hose shall conform to the following requirements as to tensile strength:

	POUNDS PER SQUARE INCH	
	Minimum	Maximum
Inner tube	800	1200
Cover	700	1100

Duck. (*b*) From the three (3) inch section remaining after the friction, stretching, and tensile tests are made, a strip of duck the entire length of this section will be taken. One piece will be cut three (3) inches wide and parallel with the warp threads of the duck; another piece will be cut three (3) inches wide parallel with the filler threads. The tensile strength of each of these pieces shall be determined by the use of grips as shown in Fig. 1 placed one (1) inch apart

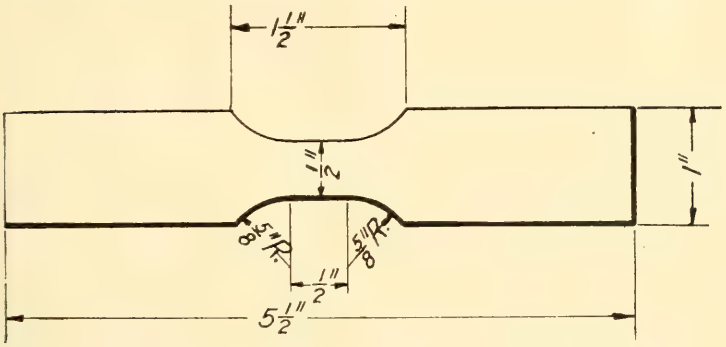


FIG. 2. DIMENSIONS OF DIE FOR TENSILE STRENGTH SPECIMENS.

directly opposite one another on the center of the test section. The section thus tested must develop a tensile strength of at least two hundred twenty-five (225) pounds per inch for both warp and filler threads. The rate of separation of the grips shall be approximately twenty (20) inches per minute, and in no case shall the test be counted when the duck breaks in the grips.

(*c*) Tension test specimens shall be taken from each lot of two hundred (200) ordered.

(*d*) Tensile strength specimens from tube and cover shall be cut with a die of dimensions as shown in Fig. 2.

III. SIZE AND DIMENSIONS

9. The hose shall be smooth and regular in size throughout its entire length, and shall conform to the following sizes:

SIZE AND DIMENSIONS OF HOSE

Dimension	Size of hose					
	3/4 inch		1 1/8 inch		1 3/8 inch	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
Length.....	Specified length	1/2 inch under that specified	Specified length	1/2 inch under that specified	Specified length	1/2 inch under that specified
Outside diameter.	1-13/32	1-3/8	1-7/8	1-13/16	2-1/8	2-1/16
Inside diameter...	25/32	3/4	1-3/16	1-1/8	1-7/16	1-3/8
* Thickness of cap vulcanized on..	3/32	1/32	3/32	1/32	3/32	1/32
Thickness of inner tube.....	.....	3/32	.....	3/32	.....	3/32
Thickness of cover	.....	1/16	.....	1/16	.....	1/16

Note: All dimensions are in inches.

IV. WORKMANSHIP

INNER TUBE:

10. The inner tube may be made either by hand or machine. It shall be free of holes and other imperfections, and shall be so firmly joined to the cotton fabric that it cannot be separated without breaking or splitting the tube.

WRAPPING:

11(*a*) The canvas or woven fabric used as a wrapping for the hose shall be made of long fibre cotton, loosely woven, from thirty-eight (38) inches to forty (40) inches wide, and shall weigh not less than twenty (20) to twenty-two (22) ounces per yard, respectively.

(*b*) The wrapping shall be frictioned on both sides and shall have, in addition, a distinct coating or layer of gum between each ply. It shall be applied on the bias with edges lapped at least one-half (1/2) inch.

V. MARKING

SERIAL NUMBER:

12. Each lot of hose of two hundred (200) or less shall bear the manufacturer's serial number, commencing with "1", on the first of each year and continuing consecutively until the end of the year.

LABEL:

13. Each hose shall have vulcanized on it a label of red or white rubber as shown in Fig. 3, located six (6) inches from one end. Lettering and figures shall be not less than one-quarter (1/4) inch high, except name of the manufacturer, which shall be not less than

* When agreed between purchaser and manufacturer, caps may be omitted from ends of hose. This is to enable prompt shipments of odd lots cut to specified length.

one-eighth (⅛) inch high. All letters and figures to stand in relief, not less than one thirty-second (1/32) inch.

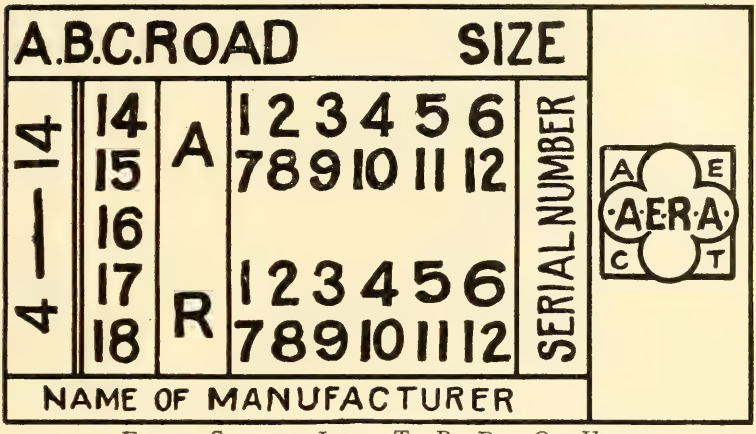


FIG. 3. SHOWING LABEL TO BE PUT ON HOSE.

VI. INSPECTION AND REJECTION.

INSPECTION:

14(*a*) Inspection shall be made at destination, unless otherwise specified on order. The manufacturer, however, shall not rely upon the purchaser's inspection but shall provide sufficient inspection to ensure against shipment of hose that do not conform to this specification.

(*b*) Where inspection is called for to be made at place of manufacture, the manufacturer shall afford the purchaser's inspector, free of cost, all reasonable facilities to satisfy him that hose are being furnished in accordance with this specification.

ACCEPTANCE:

15. If the test hose conforms to Sections 2 to 6, inclusive, the entire lot from which it was taken will be examined and those complying with the specification will be accepted.

REJECTION:

16. If the test hose fails to meet the requirements of Section 2 to 6, inclusive, the entire lot from which it was taken will be rejected and the manufacturer notified.

FREIGHT CHARGES ON REJECTED HOSE:

17. Rejected material will be returned to the manufacturer, who shall pay freight charges both ways.

RETESTS:

18. Hose rejected in accordance with Section 16 will be held for twelve (12) working days from date of test report. In case of dissatisfaction with results of the tests, the manufacturer may make claims for re-testing within that time.

DESIGN OF LIMIT OF WEAR GAUGE

This Sub-committee has considered various types of gauges, including the limit gauge recently adopted by the Central Electric Railway Association, but up to the present time they have not been able to design a satisfactory form of gauge that would be generally acceptable and we, therefore, recommend that this subject be continued for investigation of the ensuing Committee.

REVISION OF STEEL WHEEL DESIGN

The Sub-committee was instructed to formulate a design of wheel suitable for diameters of 21, 22, 24, 26, 28, and 30 in. to be added to the designs of larger diameter of wheels, as per the Association's present Standards, and we submit herewith two sheets covering detail dimensions of rolled steel wheels with diameters of 21 in. to 37 in., inclusive for adoption as Recommended Designs. Some additional diameters have been added to our former Standards, which tend to clear up some doubtful conditions. A study of this matter develops the fact that there is considerable dissatisfaction with our present standard design of rolled steel wheel of diameters from 33 in. to 37 in., with especial regard to the tread and flange contour.

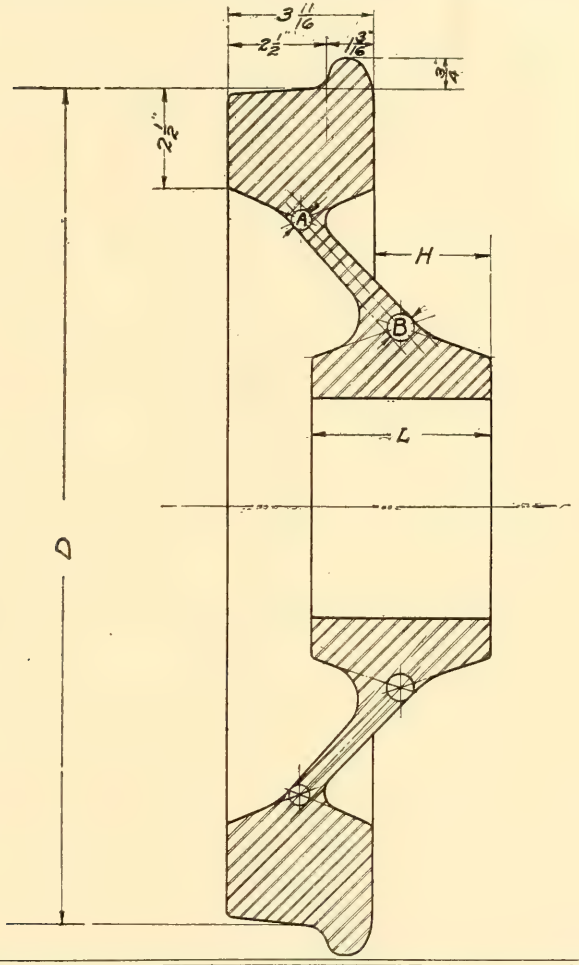
On November 19, 1914, the Central Electric Railway Association adopted a standard flange and tread contour for wheels, the form of which is different from that of the American Electric Railway Engineering Association's standard design.

The sponsors for the C. E. R. A. design claim that a close study of the situation indicates that the radius of the throat of the wheel at the gauge line should be the same as the radius of our standard rail-head section at the gauge line, and that the flange should take the form as shown on their standards to lessen the wear on guard rails and the tram portion of grooved girder rails, and the flange of the wheel itself.

Inquiry has brought out the information that the contour of flange and tread as shown on the A. E. R. E. A. Standards is used only to a small extent, and it has not only been difficult but practically impossible to secure a convincing argument that our present flange contour should stand.

Your Committee is somewhat reluctant in submitting the new design of wheels without having cleared up the question of necessity for revision of flange and tread, but in view of the underlying difficulties that would be encountered if an attempt was made to produce a new design that would meet the approval of all interests, we feel that it is best to submit at this time revised dimensions affecting the various sizes of wheels, including diameters down to 21 in., leaving the matter

(Recommended for adoption as a Recommended Design to supersede present table shown in Et 7a, Engineering Manual*)

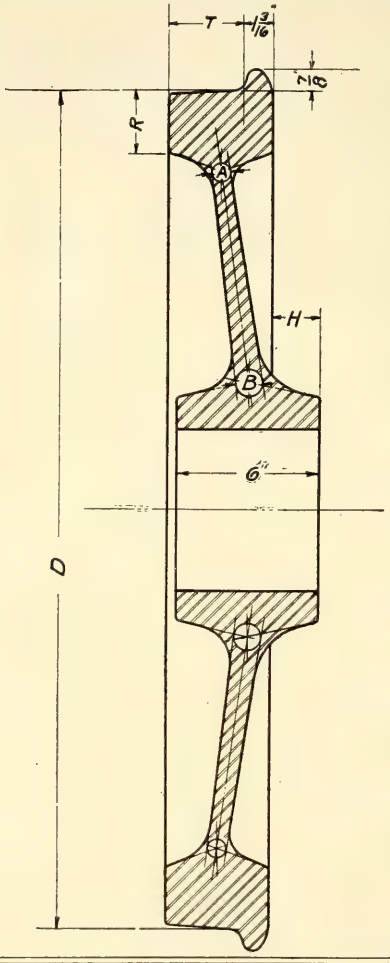


D	H	L	A	B
21″	2 15/16″	4″	1/2″	5/8″
22″	2 15/16	4″	1/2″	5/8″
24″	2 15/16″	4″	1/2″	5/8″
26″	2 15/16″	4 1/2″	1/2″	5/8″
28″	2 15/16″	5″	5/8″	3/4″
30″	2 15/16″	5″	5/8″	3/4″
33″	1 15/16″ or 2 15/16″	5 1/2″	5/8″	3/4″
34″	1 15/16″ or 2 15/16″	5 1/2″	5/8″	3/4″

FIG. 1. SHOWING DIMENSIONS OF ROLLED STEEL WIRE WHEELS WITH 2½″ TREAD.

*See page 286 for action of Committee on Standards.

(Recommended for adoption as a Recommended Design to supersede present table shown in Et 7a, Engineering Manual*)



D	T	H	R	A	B
34″	3″	1 15/16″ or 2 15/16	2½″	¾″	1″
34″	3½″	1 15/16″ or 2 15/16	2½″	¾″	1″
35″	3″	1 15/16″ or 2 15/16	3″	¾″	1″
35″	3½″	1 15/16″ or 2 15/16	3″	¾″	1″
36″	3″	1 15/16″ or 2 15/16	2½″	¾″	1″
36″	3½″	1 15/16″ or 2 15/16	2½″	¾″	1″
37″	3″	1 15/16″ or 2 15/16	3″	¾″	1″
37″	3½″	1 15/16″ or 2 15/16	3″	¾″	1″

FIG. 2.— SHOWING DIMENSIONS OF ROLLED WHEELS WITH 3 AND 3½ IN. TREADS.

*See page 286 for action of Committee on Standards.

of flange and tread contour for further consideration. We have accordingly produced designs which carry the present tread and flange contour and are arranged to fit our present standard axles, and we recommend that the next year's Committee on Equipment be instructed to investigate and report upon the advisability of a change in our standard tread and flange contour, this being particularly desirable in view of the action of the Central Electric Railway Association.

REVIEW OF EXISTING STANDARDS AND RECOMMENDATIONS ORIGINATING WITH COMMITTEE ON EQUIPMENT

After a careful review of the Standards contained in the Manual, your Committee has the following recommendations to offer:

Eb–1a — Brake Shoes, Brake Shoe Heads and Keys

It is recommended that the Standard Design for Brake Shoes, Brake Shoe Heads, and Keys, be revised to meet conditions that have developed since its adoption. Attention has been called to difficulty experienced due to uneven wear of shoes and which seems to be accounted for by the fact that the line of pressure of brake head, with shoe of the present design, is not properly located. The elimination of a portion of flange at the center we believe should also be given consideration. It is also suggested that the lug at end of shoe be eliminated and the brake head be made solid at the end to give greater bearing.

Ec–1a — Height of Platforms for City and Interurban Cars

It is recommended that in so far as this concerns city cars it should be eliminated.*

Et–3a — Design of Axles

The recent development in small size motors necessitates that the design of axles for such motors be standardized, and it is recommended that this subject be referred to the ensuing Committee to review and to add smaller sizes of axles to our present standards.

CONSIDERATION OF STANDARDIZATION RULES A. I. E. E.

We were instructed by the Executive Committee to consider the Standardization Rules of the American Institute of Electrical Engineers, as they affect the scope of your Committee, and in the event that any rule is not approved, that a recommended revision be submitted.

Articles Nos. 247 to 320: 370 to 381: 415 to 430: 436 to 449, inclusive, Edition of December 1st, 1914 of the American Institute of Electrical

*Formally approved by both the Committee on Standards and the 1915 Convention.

Engineers' Standardization Rules have been reviewed and special attention devoted to the rules governing the rating of railway matters, and, after careful consideration, it is recommended that these rules be referred to the Association for approval.*

SUMMARY OF RECOMMENDATIONS

1. That the Specification for Quenched and Tempered Carbon Steel Axles, Shafts, and Similar Forgings, reported on page 239, be adopted as a Standard Specification in place of the Association's present specification for Heat-Treated Carbon Steel Axles, Shafts, and Similar Parts.

2. That the Specification for Annealed Carbon Steel Axles, Shafts, and Similar Forgings, reported on page 244 be adopted as a Standard Specification in place of the Association's present specification for Annealed Carbon Steel Axles, Shafts, and Similar Parts.

3. That the report of Sub-committee, Subject (*a*), on Proof Testing, Forgings as reported in Appendix **A**, be published in the Engineering Manual of the Association as a guide to Member Companies in proof testing axles and similar forgings.

4. That the Specifications for Gears and Pinions as reported on pages 247 and 248 be adopted as Recommended Specifications.

5. That the subject of M. C. B. Brass for Heavy Electric Traction receive further consideration.

6. That the Revised Rules for Car Wiring and Equipment of Cars, as proposed by the N. F. P. A. Electrical Committee, as reported in Appendix **C**, be published in the Engineering Manual under the heading of "Miscellaneous Methods and Practices".

7. That the subject of Car Wiring, with especial reference to Fire Protection, be continued for investigation, with a view toward adopting a code satisfactory to our Association.

8. That the Revised Specification for Air Brake Hose be adopted as a Recommended Specification.

9. That the Design of Limit of Wear Gauge for the Association's Standard Flange Contours receive further consideration.

10. That the New Tables of Wheel Sizes shown on pages 268–270, Fig. 1 and 2, be adopted as Recommended Design in place of the present table included in the Engineering Manual Et 7a.

11. That the Committee be instructed to investigate and report upon the advisability of a change in our standard tread and flange contour.

12. That revisions of the Association's Standard Design of Brake Shoe, Brake Shoe Head, and Keys, Eb-1a, Engineering Manual be considered by the ensuing Committee.

13. That Standard Dimensions "Height of Platforms for City and Interurban Cars", Ec 1a, Engineering Manual, be eliminated in so far as this affects city cars.

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* See page 287 for action of Committee on Standards.

14. That the Association's Standard Design of Axles be reviewed with a view toward including smaller sizes to take care of recent development in motor design for low cars.

15. That Articles Nos. 247 to 320; 370 to 381; 415 to 430; 436 to 449, inclusive, Edition of December 1st, 1914, of the American Institute of Electrical Engineers' Standardization Rules, be approved.

Respectfully submitted,

L. M. CLARK,
R. N. HEMMING,
F. R. PHILLIPS,
F. W. GARRETT,
R. H. DALGLEISH,
W. W. BROWN,
W. E. JOHNSON,
WM. G. GOVE, *Chairman,*
Committee on Equipment.

APPENDIX A

REPORT OF SUB-COMMITTEE, SUBJECT (A) ON PROOF TESTING OF FORGINGS TO DETERMINE THEIR SOUNDNESS AFTER QUENCHING AND TEMPERING*

BROOKLYN, N. Y., *April* 24, 1915.

MR. WM. G. GOVE, *Chairman,*
Committee on Equipment.

DEAR SIR.— At the meeting of your Committee held in New York on January 27, 1915, you instructed the Sub-committee on Subject (*a*) to investigate the subject of "Proof-testing forgings to determine their soundness after quenching and tempering", with a view toward recommending suggestions for the purchaser's consideration in connection with the determination of proof test required for this class of material.

Your Sub-committee corresponded with various steel makers and inspection bureaus relative to this matter, and has visited steel plants for the purpose of ascertaining facilities and requirements for such tests, and also made it a matter of business at a meeting of the Sub-committee with the manufacturers' representatives and representative from the Committee on Heavy Electric Traction, held in New York on April 15, 1915.

Up to the present time, proof testing has been mostly confined to locomotive driving axles and the distance between supports usually placed at 3 ft., with height of drop generally based on the following formula:

$$H = \frac{d^3}{100}$$

Wherein:

H = Height of drop in feet,
and d = Diameter of axle in inches.

Testing Machine — Standard M. C. B. with spring supported anvils.
Weight of tup — 1640 lb.

So far as we can learn, these tests were established through experiments conducted to determine the blow required to produce permanent set, and the theory developed for the M. C. B. car axle drop test with the modifications necessary to change from a destructive to a proof test.

The accompanying table has been prepared to give a suitable height of drop uniform for both ends of each size of axle, but increasing with the size, and includes heights of drop for both 1640 and 2000 lb. tups, for reasons given later in this report. This table is based on the formula above given, with compensation made for the varying cross section of axles and was calculated for the rough turned sizes of Association's standard axles, allowing ¼ in. on the diameter for finishing.

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* See page 286 for action of Committee on Standards.

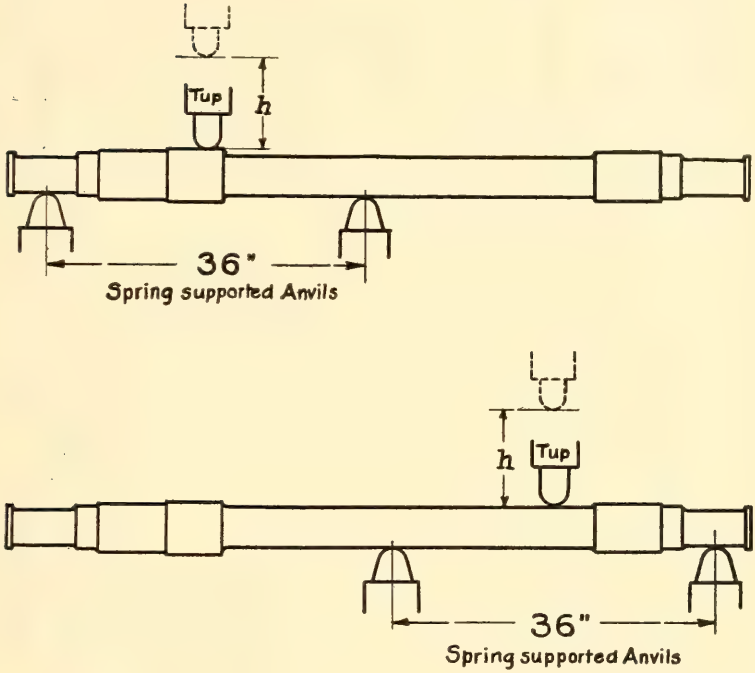

TABLE SHOWING HEIGHT OF DROP "h."

Axle		Drop with 1,640 lb. tup	Drop with 2,000 lb. tup
Size	Designation		
$3\frac{3}{4}''$ x 7″	E A	15″	12″
$4\frac{1}{4}''$ x 8″	E B	18″	15″
$4\frac{1}{4}''$ x 8″	E B-1	24″	21″
5″ x 9″	E C	30″	24″
5″ x 9″	E C-1	36″	30″
$5\frac{1}{2}''$ x 10″	E D	45″	39″

FIG. 1.—METHOD OF SUPPORTING AXLES WITH TABLE GIVING SUGGESTED HEIGHTS OF DROP

Axle	A
$3\frac{3}{4}''$ x $7''$	$41\frac{1}{4}''$
$4\frac{1}{4}''$ x $8''$	$41\frac{3}{4}''$
$5''$ x $9''$	$42\frac{3}{4}''$
$5\frac{1}{2}''$ x $10''$	$43\frac{3}{4}''$

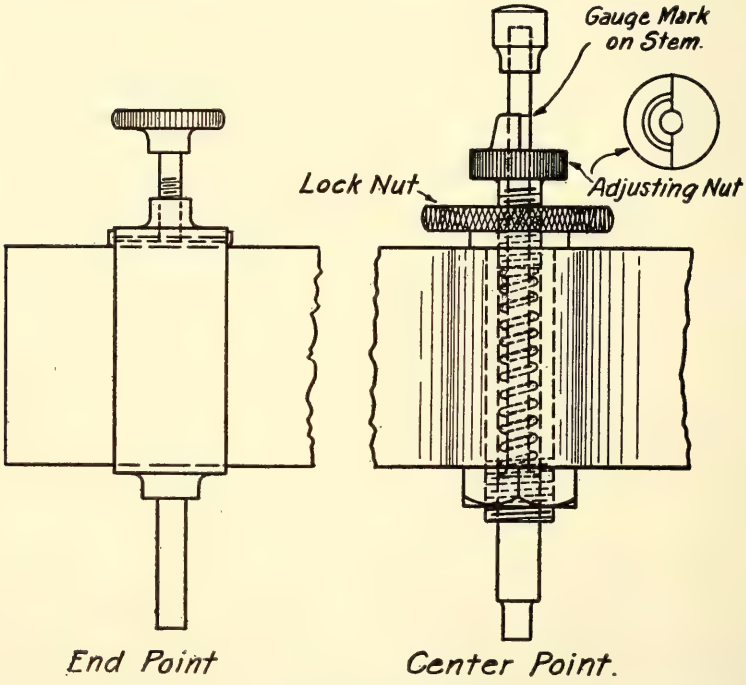

FIG. 2.— SUGGESTED DESIGN OF GAUGE FOR DETERMINING IF AXLES TAKE SET IN PROOF TESTING.

It is recommended that wherever practicable, the proof test be made after the rough turning of forging.

Due to the many variables governing a test of this kind, some of which cannot be ascertained with any degree of accuracy, it is impossible to calculate the proper height of drop for a definite fibre stress. The ideal proof test is one that subjects all parts of the forging to a stress slightly under its elastic limit, and under no circumstances should the elastic limit of the material be exceeded; therefore, when it is considered that the stress, due to a drop test, is dependent on not only the weight of tup, height of drop, and distance between supports, but also on the hardness of the material, the relation between the mass of the forging tested and the anvils upon which it rests, the capacity and flexibility of springs which support the anvils, and other details of the testing apparatus, it can be readily seen that the ideal test can only be approximated, and the table given herein should be taken, therefore, as a guide in indicating what has been found, from actual use, to as nearly as possible fulfill the requirements.

While a 1640 lb. tup has been generally used in the past in the standard proof testing machine, we are informed that the M. C. B. Association is considering adopting a tup weighing 2000 lb. on account of the lighter weight not being sufficient for a destructive drop test with the present height of testing machine and the largest standard car axles, and in order that it shall not be necessary to change weight between the different tests, it has been suggested that the newly proposed standard weight of tup of 2000 lb. be used for proof testing, with a corresponding reduction in height of drop.

It is the usual practice to turn the forging after each test so as to provide drop test on two opposite sides. Any drop test of this sort should not cause permanent set in sound forging, and provision should be made in the agreement with the manufacturer that permanent set in forging shall be cause for rejection. A suggestion for gauge to determine the set in forgings is shown in Fig. 2.

It is recommended that this report be published in the proceedings of the Association, in the form of an appendix to the report of the Committee on Equipment, as a general guide for the testing of axles and similar forgings.

Respectfully submitted,

W. E. Johnson, *Chairman,*
R. H. Dalgleish, *Vice-Chairman,*
Sub-committee, Subject (*a*).

APPENDIX B

STANDARD FLEXIBLE CABLES

Nearest A. W. G. size. (See note 1)	Circular mils	Number of wires	Size of each wire A. W. G.	Make-up. (See note 2)
.....	1,100,000	427	16	61 x 7
.....	875,000	427	17	"
.....	694,000	427	18	"
.....	550,000	427	19	"
.....	436,000	427	20	"
.....	345,913	427	21	"
.....	274,390	427	22	"
.....	264,698	259	20	"
0000.....	209,816	259	21	37 x 7
000.....	166,433	259	22	"
00.....	135,926	133	20	19 x 7
0.....	107,743	133	21	"
1.....	85,466	133	22	"
2.....	67,764	133	23	"
3.....	53,732	133	24	"
4.....	39,695	49	21	7 x 7
5.....	31,487	49	22	"
6.....	24,966	49	23	"
7.....	19,796	49	24	"
8.....	15,700	49	25	Optional
9.....	12,500	49	26	(See note 3)
10.....	9,900	49	27	"
11.....	7,840	49	28	"
12.....	6,220	49	29	"
Smaller.....	.....	To equal required size	30	Bunched

Note 1. The A. W. G. sizes are approximated within 5 per cent.

Note 2. 61 x 7 signifies a rope-lay cable composed of 61 strands of 7 wires each.

Note 3. Rope-lay or bunched.

APPENDIX C

PROPOSED CODE OF RULES FOR CAR WIRING*

40. Car Wiring and Equipment of Cars

NOTE.—This rule applies both to low potential and high potential systems.

The following rules apply to all cars or locomotives used for electric railway service, and cars or locomotives for other railway service which are equipped with electric circuits.

a. PROTECTION OF CAR BODY, ETC.

1. Where the underside of car bodies is composed wholly or in part of combustible material under which any apparatus is mounted, a protection of approved fire resisting and heat insulating material not less than one-quarter (¼) inch in thickness, or sheet iron or steel, not less than four-hundredths (.04) inch in thickness must be provided as follows:
2. Over motor trucks the protection must extend the entire width of the car and lengthwise of the car to a distance of at least twelve (12) inches beyond the area under which the flexible motor leads, contact shoe leads, brake shoes, and motor, exclusive of gear case, may come in any operating position. In all cases fireproof material or sheet iron or sheet steel must have joints well fitted and must be securely fastened, and the whole surface must be treated with a moisture repellant paint.
3. Over resistances, contactors, lightning arresters, air compressor motors and other electrical apparatus and conductors except where their casings provide approved protection for the car body, non-metallic, fire resisting, heat insulating material must extend to the edge of the car or not less than eight (8) inches beyond all edges of the devices.
4. All conductors (except flexible motor leads), leads over grid resistance, and as provided in Sec. (*d*) Par. 7) on the underside of car bodies, must be installed either in approved conduit or in approved totally enclosed fire resisting ducts. Leads must be brought out of conduits or ducts through approved fittings.

b. WIRES, CABLES, ETC.

1. All conductors must be stranded and must comply with the requirements of this Code for rubber-covered wires and cable. Fixture wire will not be permitted.

   The allowable carrying capacity of wires shall be determined by Table A of No. 18 except that motor, trolley and resistance leads shall be not less than No. 7 B. & S. For heater circuits, arc headlight and air compressor circuits, conductors shall be not less than six thousand (6000) circular mils cross

* See page 287 for action of Committee on Standards.

section area and for lighting and other auxiliary circuits, conductors shall be not less than four thousand (4000) circular mils cross section area.

The leads between the car body and main motors shall be flexible and triple braided.

The current values used in determining the size of motor, trolley and resistance leads shall be the per cent of the full load current, based on one hour rating of the motor, as given by the following table:

Size each Motor	Motor Leads	Trolley Leads	Resistance Leads
75 H. P. or less	50%	40%	15%
Over 75 H. P.	45%	35%	15%

2. Must be so spliced or joined as to be both mechanically and electrically secure without solder. The joints must then be soldered and covered with an insulation equal to that on the conductors. Joints made with approved splicing devices and those connecting the leads at motors, plows or third-rail shoes need not be soldered.

3. Cable connection to all apparatus, excepting drum controllers, must be made as follows:

Cables not larger than No. 12 B. & S. must be attached, (*a*) by having all strands dipped in solder and clamped under a screw head, and against a metal base provided with a projection or lug for retaining the cable under the screw head, or (*b*) by a flat terminal soldered to the cable and clamped to a base or post by means of a screw or nut, or (*c*) by inserting all strands in a hole in a block or post and holding by a set screw, or (*d*) by other approved method of connection.

Cables larger than No. 12 B. & S. must be attached (*a*) by a terminal soldered to the cable and securely fastened to the device by a bolt, or screw or by clamping, or (*b*) the end of cable may be held by a clamp so designed as to prevent a separation of the cable strands, or (*c*) the end of the cable after the insulation is removed shall be dipped in solder and be fastened into the device by means of at least two set screws having check nuts, (*d*) by other approved method of connection.

c. CUTOUTS, CIRCUIT BREAKERS AND SWITCHES.

1. Cutouts must be of approved cartridge or approved blow out type. Circuit breakers and switches including oil circuit breakers and oil switches must be of approved types.

2. All cutouts and switches having exposed live metal parts must be located in cabinets. Cutouts and switches, not in iron boxes or in cabinets, must be mounted on not less than one-quarter (¼) inch fire resisting, insulating material, which must

project at least one-half (½) inch beyond all sides of the cut-out or switch.

3. Cutout and switch cabinets must be substantially made of steel not less than one-sixteenth (1/16) inch in thickness or of hard wood. For cabinets containing switches or cutouts having exposed live metal parts, the entire inside including the door must be lined with an approved fire resisting, insulating material not less than one-quarter (¼) inch thick, securely fastened and treated with a moisture repellant paint.
4. Circuits carrying constant loads, such as lighting heater circuits, etc., must not be fused at more than the rated capacity of the cables as given in Table A of No. 18.
5. Light, control, heater and auxiliary circuits may be taken off ahead of the main power cutout but must each be separately fused.
6. Circuit breakers may be housed in a cabinet of metal or of wood lined with approved, fire resisting insulating material not less than one-quarter (¼) inch thick. Care must be taken that the arc chute is placed so that the arc will not come into contact with any woodwork or grounded metal. The conduit carrying the wires must end just outside the cabinet.
7. Where power is derived from both a third-rail and an overhead trolley, a switch must be installed by which the third-rail shoe may be cut out when not in use.

d. CONDUIT.

When from the nature of the case, or on account of the size of the conductors, the ordinary conduit and junction box construction is not possible, a special form of conduit system may be used, provided the general requirements as given below are complied with.

When conduit is used, outlets must be provided with approved outlet boxes, or when wires are fully protected from mechanical injury, the outlet box may be omitted and conduit fitted with an approved bell mouth or approved bushing.

1. Conduits, outlet and junction boxes must be of approved type. Conduit for lighting, heating and air compressor circuits need not be larger than one-quarter (¼) inch electrical trade size. Where exposed to dampness, conduit system must be so installed as to exclude moisture from wheelwash and other causes.
2. Conduit must be continuous between and be firmly secured into all outlet or junction boxes and fittings, making a thorough mechanical and electrical connection between same.
3. Conduits, where they enter all outlet or junction boxes and fittings, must be provided with approved bushings fitted so as to protect cables from abrasion.
4. Conduit must be permanently and effectively grounded.
5. Junction and outlet boxes must be installed in such a manner as to be accessible.

6. All conduits, outlets or junction boxes and fittings must be firmly and substantially fastened to the framework of the car.
7. For a. c. circuits carrying over one hundred fifty (150) amperes and located wholly below the car body, conduit may be omitted.

e. MOULDING.

1. Must be of an approved type, and may be installed only where not subject to moisture. Metal moulding must be permanently and effectively grounded.

f. LIGHTING AND LIGHTING CIRCUITS.

1. Receptacles and clusters must be of approved type.
2. Circuits must be run in approved conduit or approved metal moulding, except that for circuits of seven hundred (700) volts or less conductors may be installed in approved non-metallic moulding.
3. When conduit or metal moulding is used, receptacles or clusters must be mounted on approved outlet boxes or in other approved manner, and the exposed metal parts must be thoroughly grounded.
4. When circuits are run in non-metallic moulding receptacles or clusters must be mounted on blocks of hard wood or fire resisting insulating material.
5. Headlight circuits when under the car body must be in conduit. Resistance must be well ventilated and mounted as specified in Section *a*. Plugs and plugging receptacles must be of approved type.
6. Lamp or voltage regulators and controllers for axle driven or power driven generator equipments for car lighting service must be installed in approved cabinets and ventilated.
7. Storage batteries for car lighting or car control must be installed in an approved manner.

g. HEATERS AND HEATER CIRCUITS.

1. Heaters must be of approved type. Metal enclosures must be thoroughly grounded.
2. Panel heaters should preferably be mounted in metal risers set back at least four (4) inches from front edge of seat to prevent pocketing of heated air by clothing of passengers.

   The heating element must be located at least four (4) inches from all unprotected woodwork. If the woodwork is protected by at least one-quarter (¼) inch thick approved fire resisting insulating material, this distance may be reduced to two (2) inches.
3. Heaters for cross seats must be so located that heating element will be at least six (6) inches below combustible material

of seats, unless underside of seat is protected by not less than one-quarter (¼) inch fire resisting, insulating material, or four hundredths (.04) inch sheet metal with one (1) inch air space over same, when the distance may be reduced to three (3) inches.

4. Circuits must be run in approved metal conduit and connection of wires to heater must be protected from mechanical injury.

h. AUXILIARY MOTOR CIRCUITS.

1. Motor frame must be thoroughly grounded. Motors when in a confined space must be in an approved metal box or a wooden box lined with one-quarter (¼) inch fire resisting, insulating material and ventilated.
2. Circuits under the car floor must be run in metal conduit.
3. Air compressor governor must be of the enclosed type or must be enclosed in an approved cabinet or box.

i. MAIN CIRCUITS AND DEVICES.

1. Conductors connecting between trolley base and main cutout or circuit breakers must have an insulation approved for the voltage carried, and where run lengthwise of the car must be run on a wooden strip mounted on three-eighth (⅜) inch filler blocks, located at such a distance apart as to allow water to pass freely under it. The running board may be used for this purpose. The trolley lead must be securely fastened to trolley base, must be arranged to prevent the entrance of moisture where passing through roof.
2. Current collectors (such as trolley stands, pantographs, third-rail shoes, etc.) must be supported on well seasoned and thoroughly painted hard wood or other insulating supports approved for the voltage carried.
3. Conductors connecting between third-rail shoes on same track must be supported in a hard wood or insulating moulding, or in metal conduit. If the conductor is run in conduit, it must be fused as near as possible to the contact shoe before entering the conduit.
4. Conductors on the underside of the car must be run in metal conduit. Junction boxes, or other approved fittings must be installed where branches in conduit are made. Main cables between controllers (at either end of the car) may be in cable boxes in the interior of the car. Cable boxes, if of wood, must be at least five-eighths (⅝) inch thick, lined with one-quarter (¼) inch fire resisting, insulating material, with approved floor bushings.

Cables or power circuits (where exposed under car floor) must be run in metal conduit, terminating with approved bell mouths or bushings. Conduits, where they terminate above the car

floor must project at least one (1) inch above the floor line of the car body or platform.

5. Motor leads where leaving the motor shell must be snugly and well bushed with high grade rubber bushings. Motor leads must be rigidly supported on the motor frame by hard wood or other approved cleats. Motor leads must be connected with cables on car body by approved connecting devices. Motor leads must be fastened to car body by hard wood cleats placed on each side of the motor lead connectors; or motor leads may be connected to cables on car body in an approved form of junction box.
6. Resistances must be so located that there will be at least six (6) inch air space between resistances proper and the fire resisting, insulating protection of the combustible material of the car. Resistance grids must be thoroughly insulated from resistance frames, and frames must be insulated from supports.

   The insulation must be removed from conductors for at least six (6) inches back from resistance terminal. The bare stranded wire must be filled with solder to make it rigid.
7. The frames of all electrical apparatus under the car, except the main and auxiliary motors and transformers, may be insulated from the car framing.
8. Metal cases and frames of controllers located above the car floor must be thoroughly grounded.
9. When necessary, guards constructed of sheet metal must be provided to protect the resistances and other devices from wheel wash, dirt, etc.

j. LIGHTNING ARRESTERS.

1. Must be located as to protect all auxiliary cirmuits in addition to main motor circuits, and must be connected ahead of all metal conduit or moulding.
2. Must have an adequate ground connection of not less than No. 12 B. & S. wire run in as straight a line as possible to the ground, and must be properly protected from mechanical injury by fire resisting insulating moulding or wooden moulding.
3. Circuit for lightning arresters need not be run in metal conduit.

k. GENERAL RULES.

1. Insulating joints must be provided below the top of the car roof, in whistle and smoke pipes, which project above the level of the car roof or projecting portions of such pipes must be surrounded by substantial guard or cage not in electrical connection with such pipes.

   All coal burning heating devices must be thoroughly grounded. An adequate insulating cover over hot water tanks projecting above car roof must be provided.

REPORT OF COMMITTEE ON STANDARDS CONCERNING CERTAIN RECOMMENDATIONS OF THE COMMITTEE ON EQUIPMENT

1914–1915

Recommendation of the Committee on Equipment:

(*a*) As STANDARD: Specification for Quenched and Tempered Carbon Steel Axles, Shafts and Similar Forgings, as shown on page 239 of this Report. That it be adopted as a Standard Specification, to supersede present Standard Specification for Heat-Treated Carbon Steel Axles, Shafts and Similar Parts, shown as Section Et 9a of Engineering Manual.

Action of Committee on Standards:

Adoption as a **Standard Specification** approved.

Recommendation of the Committee on Equipment:

(*b*) As STANDARD: Specification for Annealed Carbon Steel Axles, Shafts and Similar Forgings, as shown on page 244 of this Report That it be adopted as a Standard Specification to supersede present Recommended Specification for Annealed Carbon Steel Axles, Shafts and Similar Parts, shown as Section Et 11a of Engineering Manual.

Action of Committee on Standards:

Adoption as a **Standard Specification** approved.

Recommendation of the Committee on Equipment:

(*c*) As RECOMMENDED SPECIFICATION: Specification for Case Hardened Forged Steel Gears, as shown on page 248 of this Report. That it be adopted as a Recommended Specification.

Action of Committee on Standards:

Adoption as a **Recommended Specification** approved.

Recommendation of the Committee on Equipment:

(*d*) As RECOMMENDED SPECIFICATION: Specification for Quenched and Tempered Forged Carbon Steel Gears, as shown on page 250 of this Report. That it be adopted as a Recommended Specification.

Action of Committee on Standards:

Adoption as a **Recommended Specification** approved.

Recommendation of the Committee on Equipment:

(*e*) As RECOMMENDED SPECIFICATION: Specification for Case Hardened Forged Steel Pinions, as shown on page 256 of this Report. That it be adopted as a Recommended Specification.

Action of Committee on Standards:

Adoption as a **Recommended Specification** approved.

Recommendation of the Committee on Equipment:

(*f*) As Recommended Specification: Specification for Quenched and Tempered Forged Carbon Steel Pinions, as shown on page 256 of this Report. That it be adopted as a Recommended Specification.

Action of Committee on Standards:

Adoption as a **Recommended Specification** approved.

Recommendation of the Committee on Equipment:

(*g*) As Recommended Specification: Specification for Air Brake Hose, as shown on page 263 of this Report. That the revised Specification be adopted as a Recommended Specification, superseding present Recommended Specification adopted in 1914. (See 1914 Proceedings, p. 292.)

Action of Committee on Standards:

Adoption as a **Recommended Specification** approved.

Recommendation of the Committee on Equipment:

(*h*) As Recommended Design: Dimensions of Rolled Steel Wheels of 2½ in. tread and 21 in. to 37 in. diameter, as shown on page 269 of this Report. That it be adopted as a Recommended Design.

Action of Committee on Standards:

That it be referred back to the Committee for consideration in conjunction with the Design of Contour of Tread and Flange and further study as to Thickness of Rims.

Recommendation of the Committee on Equipment:

(*i*) As Recommended Design: Revision of Standard Rolled Steel Wheel Design for 3 in. and 3½ in. tread, as shown on page 270 of this Report. That it be adopted as a Recommended Design.

Action of Committee on Standards:

That it be referred back to the Committee for consideration in conjunction with the Design of Contour of Tread and Flange and further study as to Thickness of Rims.

Recommendation of the Committee on Equipment:

(*j*) Revision of Tread and Flange Contour, as shown on page 268 of this Report. That it be investigated next year, due to the C. E. R. A. adoption of a different design than that of this Association.

Action of Committee on Standards:

Referred back to Committee for further study.

Recommendation of the Committee on Equipment:

(*k*) Proof Testing of Forgings, as shown on page 274 of this Report. That the Report of the Sub-committee be printed in the Engineering

Manual under Miscellaneous Methods and Practices as a general guide in proof testing axles and similar forgings.

Action of Committee on Standards:

Approved Recommendation of Committee on Equipment.

Recommendation of the Committee on Equipment:

(*l*) Rules for Car Wiring, as shown on page 279 of this Report. That they be printed in the Engineering Manual under Miscellaneous Methods and Practices.

Action of Committee on Standards:

Recommendation that these rules be printed in Engineering Manual, under Miscellaneous Methods and Practices, approved.

Recommendation of the Committee on Equipment:

(*m*) Height of Platforms for City and Interurban Cars, part of Section Ec 1a of Engineering Manual. In so far as this concerns city cars, it should be eliminated.

Action of Committee on Standards:

Recommendation that in so far as this concerns city cars, it should be eliminated, approved.

Recommendation of the Committee on Equipment:

(*n*) Standardization Rules of A. I. E. E., 247–320; 370–381; 415–430; 436–449 inclusive. That these be referred to Association for approval.

Action of Committee on Standards:

That this subject be given further consideration in view of the fact that these rules have been further revised by the A. I. E. E. since their consideration by the Committee, the new issue bearing date of July 1, 1915.

Respectfully submitted,

C. F. Bedwell,
W. G. Gove,
E. R. Hill,
A. S. Richey,
J. W. Welsh,
C. S. Kimball,
E. B. Katté,
W. H. Sawyer,
F. R. Phillips,
J. H. Hanna,
C. H. Clark,
Martin Schreiber, *Vice-Chairman,*
H. H. Adams, *Chairman,*
Committee on Standards.

PRESIDENT CRECELIUS:— In considering this report the plan adopted at our former meeting, namely, to consider first the definite recommendations of the Committee, and at the same time the action of the Committee on Standards, will be followed after which the report as a whole will be opened up for general discussion. The first definite recommendation is that the Specification for Quenched and Tempered Carbon Steel Axles, Shafts and Similar Forgings, as shown on page 239 of this report, be adopted as a Standard Specification, to supersede the present Standard Specification for Heat-Treated Carbon Steel Axles, Shafts and Similar Parts, shown as section Et 9a of *Engineering Manual.*

JOHN LINDALL:—The Committee on Standards recommends the adoption of this as a Standard Specification.

C. R. HARTE:— I move that the recommendation be approved.

W. G. GOVE:— I might say that in the work of the Committee on Equipment, the chairmen of the sub-committees were so appointed, so far as we were able to take care of the matter, that the one in direct charge of the sub-committee work was particularly proficient in the line of work referred to his sub-committee. The action of the Committee on Equipment having as it has an important bearing upon the maintenance of rolling stock and the purchases of the various companies affected, made it desirable, especially as some of those matters were up for final adoption as standard specification, to approach the matter very carefully and very thoroughly, and their action has been taken with that in mind, that is, not only have the chairmen of the sub-committees, given very careful and thorough consideration to these special matters, but the members of the Committee as a whole have endeavored to give the entire subject very thorough consideration; and also in our several meetings of the committee as a whole, which were very well attended,— we took time enough to go into the matter very thoroughly.

With regard to the question of axles, undoubtedly many of you gentlemen will remember the discussion which we had originally when the matter was first taken up, some four or

five years ago, and which was due principally, I think, to the fact that the Interborough Rapid Transit Company of New York at that time was considering heat-treated axles.

The subject is, of course, not only a very important one, but it is one of increasing importance to all companies, regardless of the type of rolling stock, because it involves not only the use of a better grade of material, but the permissible use of smaller axles in many instances than would otherwise be safe. I only bring this out at this time to try to make plain the fact that the action, as taken by the Committee on Equipment, was earnest and sincere, and we tried, as far as possible, to give it that attention that I believe you gentlemen desire and the Convention would expect, not superficial action.

I would explain this one further feature—we all thoroughly understand and appreciate the fact that the mechanical head of any electric railway property is not an expert in all the lines of work he is called upon to take care of or review, or oftentimes to pass upon, in the design of equipment, or in its later maintenance, including the purchase of supplies. The active coöperation and assistance of the manufacturers is always an essential. Without that coöperation, without that assistance in the right way, no real progress can be made. Arbitrary action by the engineers or by the maintenance men would be unwise and might be productive of very bad results. On the other hand, I think we all agree that the action of the manufacturer, concerned with his processes of manufacture only, with the possibility of producing material at least cost, sometimes, or at least, such a standard as will permit tonnage without due and full regard for the purchasers' interests, would also be foolish.

It is only through coöperative action taken in the right way, not only inviting the manufacturers to coöperate, but making sure that their attention is called to those proposed recommendations, whether as Recommended Specifications or as Standard Specifications, that we will really make progress. Therefore, we always invite and welcome that coöperation and assistance, as it is real assistance. On the other hand, it is always well, in fact necessary, to bear in mind that, as engineers and as the active heads of the mechanical departments

of our various properties, we are called upon in a technical capacity to pass upon terms to make sure that the railroad in its purchases obtains what it most requires, and while there are certain differences in local conditions, which I am well aware of, having worked for three different properties and resided in all sections of the United States — I lived in California for five years — I also fully appreciate that in general our requirements are largely the same.

In this matter of quenching and tempering steel axles, there would be no difference in the specifications — it is not a question of climate or service, but it is a question of weights, tonnage and speed, and such features as that may be put in any general specification, and can and should apply to all. Therefore, although we want the assistance, and cannot get along without the assistance of the manufacturer, and especially that technical assistance that goes with their work, not through their sales department at all times by any means, at the same time we must bear in mind that the engineer in charge has his own responsibility to his own management, to make sure that the railroad, the purchaser, the company that pays the bills, gets what it requires, and what it means to purchase.

In this connection I desire to read the following communication.

In connection with proposed revision of Specifications for Quenched and Tempered Carbon Steel Axles, we note in Section 11, proof tests, it is stated that the details of this test shall be agreed upon by the manufacturer and the purchaser. On pages 274 to 277, inclusive, is given only the method employed by the Standard Steel Works Company, with the foot pounds and details of machine, the same as adopted by the Pennsylvania Railroad for use with a standard M. C. B. axle drop testing machine.

I would call your attention to the report of the sub Sub-committee of the American Society for Testing Materials, giving the information collected on this subject.

In your report you state on page 274 that up to the present time proof testing has been mostly confined to locomotive driving axles and the distance between supports is usually placed at three feet, with height of drop generally based on the formula adopted by the Pennsylvania Railroad. I cannot entirely agree with this statement, for while proof-testing was originally worked out for driving axles, it has been since then much more extensively used for heat-treated electric railway or

other car axles than for driving axles, since the number of driving axles used in comparison with other types is relatively small. Further, I cannot agree that the distance between supports has been usually placed at three feet, or that the formula you give is generally used.

In my previous letters I have said something about the development of proof testing which originated in connection with heat-treated chrome vanadium driving axles for the New York Central, which we furnished the American Locomotive Co.

It is only comparatively recently that the Pennsylvania Railroad or the Standard Steel Works undertook to develop a method of proof-testing, and in accordance with our experience and judgment, we do not consider their tests as thorough as the one which we employ.

In the report of the Sub-Sub-committee of the American Society for Testing Materials mentioned above, the three different methods of testing are given, and until it has been definitely settled, preferably by actual service, what test is best adapted for the purpose, I would urge you to give all three methods, for the consideration of the purchaser, as I see no reason why any one method should be either specially selected or discriminated against.

The chairman of that particular Sub-committee replied as follows:

Relative to report of Sub-committee in connection with proof-testing axles as given on pages 274 to 277, please note that the Sub-committee had various methods of proof-testing under consideration and at least three of these were tentatively discussed at their meeting in New York on April 15, 1915, when representatives of various steel manufacturers were present.

After full discussion and careful consideration of the different arrangements proposed, the method as indicated in our report was selected as the one which, in our opinion, would best meet the requirements for proof-testing motor-driving axles. It is not the intention, however, and as indicated in the report, that the arrangement as shown is to be taken as the final recommendation of the Committee, but shall serve as a guide for the purchaser's use in determining proof-test. As far as the Sub-committee could learn at the time they made their investigation, very little proof-testing had been done by manufacturers outside of locomotive driving axles. I am aware, however, that since that time quite large orders for quenched and tempered material for railway motor-driving axles have been placed and proof-test arranged for, and no doubt at the present time the proof-testing has been more extensively employed for this class of material.

From the reading of your letter, I do not take it that you have any criticism to make of the method indicated in our report, and as it would seem to cover the purpose for the particular class of material

indicated somewhat better than the other arrangements considered, it seems to me that until more conclusive information can be obtained on the subject, it serves the purpose intended.

I think it well to give these facts concerning the Specification for Quenched and Tempered Carbon Steel Axles, Shafts and Similar Forgings, as long as it has been written by a large manufacturing concern.

PRESIDENT CRECELIUS:— The chair, in calling on Mr. Gove for the presentation of this communication, did so, to give you an idea of the care that surrounds the preparation of these recommendations by standing committees. It is obvious from the detail which Mr. Gove has presented that these recommendations have received very careful consideration by our Committee. Is there any further discussion of this subject?

(Motion to adopt the recommendation having been duly seconded was put to vote and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the Specification for Annealed Carbon Steel Axles, Shafts and Similar Forgings, as shown on page 244 of this report, be adopted as a Standard Specification to supersede present Recommended Specification for Annealed Carbon Steel Axles, Shafts and Similar Parts, shown as section Et 11a of *Engineering Manual.*

JOHN LINDALL:— The Committee on Standards recommends its adoption as a Standard Specification.

C. R. HARTE:— I move that the specification be approved as Standard.

PRESIDENT CRECELIUS:— Mr. Gove, have you any remarks to make on this specification?

W. G. GOVE:— I do not think there are any comments necessary on the annealing specification, as the real points were made on the quenching and tempering specification. We believe it is thoroughly covered.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the Specification for Case Hardened Forged Steel Gears, as shown on page 248 of this report, be adopted as a Recommended Specification.

JOHN LINDALL:— The Committee on Standards recommends the adoption of this as a Recommended Specification.

C. R. HARTE:— I move the approval of the recommendation.

W. G. GOVE:— I do not want to weary the Convention by any unnecessarily lengthy discussion or comment on the proposed specification. It is only fair, of course, in all instances, and especially as the various sub-committees comprising the Committee on Equipment have gone into this so carefully, in justice to the manufacturers whose coöperation we have solicited, to make plain any objections which may have been filed or may have been received or any comments that have been in any way unfavorable. We have one more communication from a manufacturer, only recently received, unfortunately. I say unfortunately, because I feel very strongly on this whole subject. I would like to explain that in some of the work, especially where we had a considerable amount of construction work, as we have on the Brooklyn Rapid Transit System at the present time, we are compelled to act in several capacities, and in my own particular case I am employed in the dual capacity of engineer of car equipment and also as superintendent of equipment, for both the construction and maintenance part. Furthermore, going back over 10 or 15 years' experience, I learned some time ago, and have profited by it in very recent years, that if you can make use — I do not want to be misunderstood now — of those with whom you are associated in the manufacturing field, you will undoubtedly benefit by it. We have also, and do to-day, endeavor to coöperate — if you wish to call it that — but I would like to make it more explicit, and say that we make use in a perfectly proper and legitimate way of the technical or other representatives of manufacturing concerns. I think that if we approach the matter in that way, especially as I have pointed out that no one of us, no matter what his experience may have been, no matter what his technical training in earlier years may have been, no one of us is an expert in all the various lines we are called on to look out for in our various capacities, and by doing this, by consulting with the

manufacturers, we oftentimes will be able to profit considerably personally, and also to bring profits to our companies. We have endeavored to do it. I do not like at any time for any one to hold back — my own ideas and principles have been that when matters of this sort are up for consideration by the various committees, they should be treated squarely by everybody concerned, including the manufacturers, and any criticism should be given then and there, or within a reasonable time. I do not like these eleventh hour considerations, after others have given sincere thought and their time to the subject in advance.

Referring to your recent letter, wish to say that my previous letter was simply commenting on the different points in your specifications, as I considered it unfair to ask you at this late date to make changes in the specification except calling your attention to paragraphs which were not consistent with each other. However, if it is possible for you to have the following changes made we would certainly appreciate it. I would refer to the most important items, as follows:

Web.— Page 249, paragraph 7; page 252, paragraph 8.

A 2 in. hole in the web is, of course, perfectly satisfactory to us, but from my experience I know that such a size hole will not be accepted by the majority of the roads in the country, that is those who make a practice of pressing off the wheels without disturbing the gear. This must be done by using a jig with jack arms extended through a hole in the web, and a 2 in. hole will not permit a suitable size jack stud. The majority have insisted on four 4 in. holes 90 degrees apart and located on a common center which will permit them to use the same wheel press jig for the different sizes of gears which they use in the service. I found this ran from 64 tooth-three pitch up, and after laying out the sizes I found that a 3½ in. hole on a 7¼ in. radius was the limit, and all roads I have thus far taken it up with have agreed to make this standard. (Two inch holes supplied by G. E. Co. in our sub. gears and this size was determined by them.)

Hub.— Page 249, paragraph 9 (*b*); page 252, paragraph 10 (*b*).

Correct the variations for the length of hub extension to agree with length of hub overall.

Keyway.— Page 249, paragraph 10 (*c*) and (*d*); page 252, paragraph 11 (*c*) and (*d*); page 254, paragraph 10 (*c*) and (*d*); page 258, paragraph 11 (*c*) and (*d*).

Make sure that your fillets are not too large for the specified clearance over top of the key.

INSPECTION.— Page 250, paragraph 13 (*b*); page 253, paragraph 14 (*b*).

The paragraphs as they read will compel the manufacturer to keep a record of his tests indefinitely. With the number of gears and pinions which we manufacture it would be impossible to keep this record over six months. Would it not be possible to change this to read — "Records of all chemical analysis and physical tests, if so desired by the purchaser, shall be furnished with the material," or something to that effect?

REPLACEMENT.— Page 250, paragraph 15; page 253, paragraph 16; page 256, paragraph 15; page 259, paragraph 17.

This is an unlimited guarantee which we consider unfair to the manufacturer. I doubt if any manufacturer will bid on specifications with these paragraphs included. For instance, if the maximum life of a gear is 15 years and it should happen to break in the fourteenth year, the manufacturer would be compelled to make replacement free of charge and receive absolutely no consideration for the 14 years' service. Unknown shocks in the service and the operator's method of mounting and dismounting the material produce injurious stresses which, while not causing immediate failures, may later cause fractures which would require the diagnosis of a metallurgist to determine if there were any defects in the material, and we have learned from experience that very often metallurgists disagree. These paragraphs are really agreements which should be entered into separately by the purchaser and the manufacturer and should not be included in the specifications.

PHYSICAL PROPERTIES.— Pages 251 and 257, paragraphs 4 (*a*) and (*c*).

Change reduction in area in 2 in. in Grade No. 1 to 25 per cent and the hardness factor to 286.

Grade No. 2 is supposed, I believe, to represent material something like our Grade M. Our advertised Grade M properties are taken from a treated test bar, for the physical characteristics of a bar cut from the base of the tooth do not represent the strength of a Grade M tooth any more than a bar cut from the base of a case hardened tooth represents the strength of that tooth, and as I thought I made it clear at our meeting in New York, we can not meet the elastic limit and tensile strength of this grade with the bar cut from the base of the tooth. I know both you and your Committee will not consider specifications based on a treated test bar but if your Committee is willing to allow the treated test bar we would like to have the elongation in 2 in. changed to 0.5 and reduction in area changed to 1.5. Doubt if any manufacturer can meet Grade No. 2 as written.

The reply to that letter by members of the Sub-committee, consisting of Mr. Dalgleish, of Washington, D. C., and Mr. Johnson, of the New York Municipal Railway Corporation, associated with myself, is as follows:

I am enclosing a copy of a letter received from Mr. Ross of the General Electric Company, covering suggested changes in the Gear and Pinion Specifications. I have no objection to increasing the size of hole in web to 3½ in.

HUB: Page 249, paragraph 9 (*b*); page 252, paragraph 10 (*b*), should read: "Length of hub extension, plus 0 inch to minus 0.22 inch."

I cannot agree with Mr. Ross as to using a treated test piece in determining the physical properties of this class of material.

I am sorry that Mr. Dalgleish is not here. I am the only one representing the Committee. I say that, because a large majority of the members have gone into the various subjects so carefully that perhaps they could give you fuller information.

I am in receipt of yours together with communication addressed you by Mr. Ross of the General Electric Company, and I agree entirely with what you say in connection therewith. As to changes on pages 249 and 252, paragraph 9 (*b*) and 10 (*b*) respectively, these are typographical errors, which can be corrected before final printing, and I am bringing this to Mr. Gove's attention with a view toward notifying Mr. Burritt.

As to increase in size of hole and web, I can see no objection to this change, but there will be ample opportunity to have this investigated and change made if desirable at some future date, as the specifications are only now proposed as a Recommendation. Other matters referred to by Mr. Ross, I think will also be proper for consideration by the ensuing Committee on Equipment.

The real answer is, as brought out by Mr. Johnson, the matter at the present time is only proposed as a Recommended Specification. It is a new specification. We all have much to learn, and no doubt within the next few years, in the same way that we have followed up the Specification for Quenched and Tempered Steel Axles, we will be able to arrive at a specification satisfactory, perhaps, to the great majority, both of the manufacturers and railroad companies.

PRESIDENT CRECELIUS:— The Chair feels you have now enough information to vote intelligently on this section of the report.

(Motion by Mr. Harte (see page 292) having been duly seconded was put to vote and carried.)

C. R. HARTE:— Is it not desirable to suggest at this time that the incoming Committee on Equipment take under consideration this question of a larger web hole?

W. G. GOVE:— I think it is a proper subject for the Committee on Subjects, if they want further investigation at any time on any of these features, they can call for it.

C. R. HARTE:— I appreciate that each committee is expected to bring up to date the action of previous committees, but here a specific question has been raised and it is a question in my mind whether it may not be desirable to emphasize it.

E. D. PRIEST:— Should it be understood that these specifications are the final recommendations of this Committee? From what Mr. Gove has stated I judge the specifications are to be considered as more or less tentative. The report is an excellent one in general but I think there are some features which can be changed to advantage.

W. G. GOVE:— I think it would be proper for any manufacturer to call attention to any features which he does not believe are just all that could be desired, and in view of the fact that it is only a Recommended Specification, meaning that it will be considered further before being presented as a Standard Specification, the Committee would welcome just those criticisms. That is the main point brought out, that this is merely a start, that it is tentative, and undoubtedly will be built on within the next one, two, three or five years. As most of us know the question of gears and pinions to-day is in a transition period, and is developing so rapidly, it is pretty hard for some of us actively engaged in the business to keep up with it. The development of the next few years will be undoubtedly very great, and it would be foolish for us to adopt a standard specification for these things at this time.

PRESIDENT CRECELIUS:— The next recommendation is that the Specification for Quenched and Tempered Forged Carbon Steel Gears, as shown on page 250 of this report, be adopted as a Recommended Specification.

JOHN LINDALL:— The Committee on Standards approved the adoption of this as a Recommended Specification.

C. R. HARTE:— I move the adoption of the recommendation.

PRESIDENT CRECELIUS:— In regard to the question that Mr. Priest raised a moment ago, it is desirable to get any points of interest regarding these Recommended Specifications into the record, and therefore I want the manufacturers to feel at liberty to give us the benefit of any views they may have bearing on this subject at any time.

E. D. PRIEST:— Referring to page 251, dealing with physical properties and tests. The grade designated as No. 1, I think was in general intended to cover what is known as "G. E. Grade F" gears and pinions. For general specifications the requirements are somewhat too severe in respect to reduction in area and hardness and my suggestion would be that the reduction in area be changed from 30 per cent to 25 per cent, and hardness from 300 to 286.

Under Grade No. 2 the point has already been made that it would be difficult to meet the specifications with carbon steels. The General Electric Company has a grade of gear and pinion known as "Grade M," which approximately meets the specification, but it would have to be modified in respect to the test bar, *i. e.*, Grade M would not meet the requirements if the test bar is taken from the base of the tooth after treatment, but it would approximately meet the specifications if the test bar is treated after being cut from an untreated tooth. I think from the way the specification is written it is doubtful if it covers a grade which it is practical to produce. In fact the grade in question is such that it is not clear to me how any satisfactory tests could be made from a piece taken from the base of a tooth after treatment.

As I understand it, the Committee feels that it would not be satisfactory to test a treated bar. If this is so, I do not think I need say anything further concerning Grade No. 2, except to note that if the test of a treated bar were allowed, G. E. Grade M would meet the specifications with the following modifications:

The elongation in 2 in. should be changed from 2 per cent to 0.5 per cent, and the reduction of area from 6 per cent to 1.5 per cent.

Grade M is a hard steel with very high tensile strength and necessarily low elongation and reduction of area. I do not wish to speak from the standpoint of the General Electric Company only, and possibly there may be a steel which will meet the specifications, although I am not familiar with it.

There are some points, which Mr. Gove mentioned and which were taken up under the first section, which also apply here. I refer especially to replacement guarantees. It is hardly practicable for manufacturers to give an indefinite time guarantee, ordinarily guarantees are limited to some specific period like one year. A guarantee extending over a number of years would seem impracticable of execution and would lead to unconvincing controversy between the manufacturer and user. These are the principal points to which I would call attention at this time.

W. G. Carey:— I should be very glad to see in the record some emphasis upon the objection to attempting to determine the characteristics of the tooth by a test bar taken from the body below the root of the tooth. In my opinion, that has practically no importance as an indication of the characteristics of the tooth itself, which is what you are after. I think Mr. Priest spoke of this, but I do not think he emphasized it as much as is desirable. Certain it is that some of the materials which these grades are intended to cover cannot be so made that a test bar taken from the body after treatment can be any definite indication of the characteristics which you wish to control.

President Crecelius:— Mr. Gove, in closing the discussion, will you please reply to the gentleman?

W. G. Gove:— The points made by Mr. Priest and Mr. Carey are well taken. The principal point is simply this — in the first place, as I pointed out, this is the first and initial specification of its kind for gearing. It is desirable, I think, that such a specification be adopted at this time as a recommended specification. Perhaps it will be found desirable and

advisable to meet the points that Mr. Priest and Mr. Carey have brought out, some of them, at least. Of course, there is this to be considered — this first specification has been drawn with the assistance of three of the largest manufacturers, perhaps — I will not say necessarily the largest, as there are some other manufacturers, but covering the scope we had in view, in quenched and tempered steel gears, and case hardened steel gears, perhaps more or less naturally we leaned to and obtained the assistance of the three largest producers of that form of gearing, although other manufacturers of gears were asked to coöperate. That means that we have received the assistance of several representatives, including the experts of the General Electric Co., the Westinghouse Electric & Manufacturing Co., the R. D. Nuttall Co., and the Tool Steel, Gear and Pinion Co.

As to the test piece, I have been watching the gears very carefully — of course, we have service in the East, in the neighborhood of New York, and in fact in all of the eastern cities, Boston and Philadelphia, as well as New York, an extremely varied service, and it has been necessary to watch the development of the gearing very closely. I referred yesterday, you remember, to the point that there is a constantly varying need for obtaining higher grade of material. It will no longer be possible, at least in a general way, to buy gears as gears. We all did that in the past, but, of course, times have changed. The gear manufacturers no longer advocate such action. When we bought motors years ago we gave no thought to gearing, but we got the ordinary cast steel gears. We may have got more for our money than we get to-day, but the important point, however, is that in certain service, and especially in the high speed rapid transit service, it is absolutely necessary to eliminate failures, and that means we must obtain a gearing that will be free of failures. We are not worrying much about the wearing of the gearings so far as the teeth are concerned, for if properly lubricated all gears will give considerable life, some very long life, that is, consistent with the other mechanical restrictions, which we all understand. It is

true, however, that the failures of the high grade gearing to-day lie at the bottom of the teeth. I cannot see, therefore, but what the purchaser should more carefully investigate the gearing at the bottom or base of the tooth.

As to guarantees I appreciate that perhaps we may go too far and we may ask too much of the manufacturers. We may have to come back on some of this. On the other hand, in my own experience, where we are paying perhaps twice as much for gearing to-day as we did ten years ago, and obtaining no more mileage from it, but are merely placing that gearing in service to obtain a positive service, free from failures, I feel that we should have some reasonable guarantee as to just what we can reasonably and properly expect; it may be 50,000, it may be 100,000 miles, it may be a case of a 250,000 miles, but at any rate we should have some guarantee from the manufacturer, especially in spite of the fact that in any tests that may be made there will be some failures at low mileages. The average may be very high, but a great deal of this comes from the necessity of positive service. We want to purchase gearing to obtain a positive service, free from failures, free from delays, free from any interruptions to service which, in many places, is a very serious item, especially where there are in a number of cases trains operated at less than one minute headway, and where a tie-up through derailment or blocked line will involve perhaps riots, certainly involve the discommoding, in some cases, of anywhere from 30,000 to 50,000 people, who might be held up at ticket offices waiting to take their trains for home.

These are some of the reasons that have prompted the Committee in putting these restrictions in these specifications. We appreciate, however, fully that there may be a considerable need for revision. We know that there will be need for a new specification, because the gearing itself is in a transitional period, and the manufacturers will undoubtedly in the next few years do just as much in its development as they have done in the past few years, and that has been a very great deal.

PRESIDENT CRECELIUS:— The Chair feels that this section has been pretty thoroughly discussed and that you can now vote intelligently on the question.

(Mr. Harte's motion (page 298) having been duly seconded was put to vote and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the Specification for Case Hardened Forged Steel Pinions, as shown on page 253 of this report, be adopted as a Recommended Specification.

JOHN LINDALL:— The Committee on Standards has approved of the adoption of this as a Recommended Specification.

C. R. HARTE:— I move the adoption of the recommendation.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the Specification for Quenched and Tempered Forged Carbon Steel Pinions, as shown on page 256 of this report, be adopted as a Recommended Specification.

JOHN LINDALL:— The Committee on Standards approved its adoption as a Recommended Specification.

C. R. HARTE:— I move the adoption of the recommendation.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the Specification for Air Brake Hose as revised and shown on page 263 of this report, be adopted as a Recommended Specification, superseding the present Recommended Specification adopted in 1914.

JOHN LINDALL:—The Committee on Standards recommends its adoption as a Recommended Specification.

C. R. HARTE:— I move the adoption of the recommendation.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the section relating to Proof-Testing of Forgings, as shown on page 274 of this report, be printed in the *Engineering Manual* under Miscellaneous Methods and Practices as a general guide in proof-testing axles and similar forging.

JOHN LINDALL:— The Committee on Standards approves the recommendation of the Committee on Equipment.

C. R. HARTE:— I move the adoption of the recommendation.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the Rules for Car Wiring, as shown on page 279 of this report, be printed in the *Engineering Manual* under Miscellaneous Methods and Practices.

JOHN LINDALL:— The Committee on Standards approves of that recommendation.

C. R. HARTE:— I move the adoption of the recommendation.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— Those are all the recommendations of the Committee which are to be acted upon and we still have a few minutes for the discussion of the report as a whole. Mr. Gove will stand ready to explain, in closing the discussion, any features which you may desire.

C. R. HARTE:— There is a point which applies to all these specifications, and Mr. Gove's comments brings it out very clearly, and that is the fact that there are two points of view, each of which must be carefully considered. One is purely that of the service. An engineer unhampered by cost or production considerations, can design, let us say, an axle which will give the ultimate service and life. The other point of view is that of the manufacturer, who, unhampered by service conditions, can make the axle with the least production difficulty, and at the lowest cost. Neither is practicable in its entirety and it becomes essential to get that compromise between the production limitation for the manufacturer, and the technical limitation for the engineer, which will give us, considering all facts, the most economical axle. Not infrequently the sacrifice of certain service features will so reduce the cost, and so enlarge our ability to get what we want, as to make it economically much better than to have the better technical design. On the other hand the cost of replacing, both direct, and through its effect upon general operation, may make it wiser to pay more and wait longer for the technically better axles. Whatever the specification is for, it is highly important

that we bear in mind there are two sides to the shield, and before we insist that it be silver, we should, as Mr. Gove's committee obviously has done, look around and see if it is not gold on the other side.

PRESIDENT CRECELIUS:— As there is no further discussion, have you anything to say, Mr. Gove?

W. G. GOVE:— I will only take a few minutes of the time of the Convention, to say a few words in line with what we were discussing yesterday as to the use of the Association Standards. I was out this morning at the very excellent Exposition you are having here, and was very much interested in some special work that the U. S. Steel Corporation had upon its floor. I was particularly interested in noticing the fact that they had the Association's Standard Rail, showing that they must have provided rolls for it. The gentleman at the booth remarked to me that it had not been much in demand. I am not sure there has been any demand.

In considering the question of wheels, there is so much of our business, as we all know, that is so closely connected, one part with another, that you cannot separate it. The question of the track immediately involves the question of the wheel. The question of the wheel — it was referred to here in this report, where there is a proposed design, all of which is left over, as we wanted to take further action on it before bringing it before the Convention for action — is closely related to the new rail. In Brooklyn we have a $\frac{5}{8}$-in. flange on our surface lines. Many other street railway companies have $\frac{5}{8}$-in. flange. They undoubtedly all want $\frac{3}{4}$-in. depth of flange as a minimum.

The question of the rail came up recently in Brooklyn, and this came to my mind in having this rail shown to me this morning. Our engineer of way and structures, who also has charge of the track work and way matters, has recommended the purchase of several thousand tons of this new section of rail to the president, to whom a matter of that sort, as chairman of our contract committee, is always referred, and passed upon by him. The president asked me for my opinion. I very heartily endorsed it and we are going to buy

it. Of course, he asked me perfectly properly, and we must all be very careful to what extent we involve our companies in added expenditures from which there will be no immediate returns, just how we were going to be benefited by it. Of course, that is not the easiest matter to explain, but in general it is simply this — we are trying to progress. We have adopted this one feature now in particular, a new rail, an ideal section, to take care of a better operating wheel, and to produce a safer wheel. If we do not start somewhere, we will never get the wheel, and if we do not get the wheel, and do not get the rail, we will never get traffic. Therefore, we could, in a measure, and I believe properly so, justify the purchase of these several thousand tons of this new rail, and I heartily endorsed the purchase, and it has been approved, with the idea of taking care of further and future renewals of that rail, and in time having one or more, or many, lines laid with the new style of track, with the new rail, thus permitting of the new design of wheel.

I sincerely hope that everybody in respect to these Standards that are placed before these various Conventions and discussed, and very frequently adopted, will take them home with them, and will do everything they can to put them into actual use. These new Standards tend to better practice, and if they are more generally adopted, they will become more and more a commercial proposition, and in turn in that way be reflected, as for instance, in the case of the air brake hose, also in our ability to purchase a better grade of material at perhaps a lower cost if used on a large scale.

C. R. HARTE:— I move that the report of this Committee be received and that the thanks of the Association be extended to them for the excellent work done on the report.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— We will now take up the consideration of the report of the Committee on Buildings and Structures, of which Mr. C. F. Bedwell is chairman. Unfortunately he, as well as all the members of the Committee are absent from this Convention, and it will be necessary for us to ask the Acting Secretary to read the report in order to bring it formally before the meeting.

REPORT OF COMMITTEE ON BUILDINGS AND STRUCTURES

To the Members of The American Electric Railway Engineering Association:

GENTLEMEN:— The Executive Committee assigned the following subjects for investigation by your Committee:

Subject (*a*) — General Specifications and Form of Contract for Railway Structures.

Subject (*b*) — Proper Provision for Expansion and Contraction in Restrained Concrete Structures, consideration to be given to both Plain and Reinforced Concrete, with provision made to properly waterproof and protect such arrangements.

Subject (*c*) — Further consideration of Fire Protection Rules, especially with regard to the use of soldering and other heating equipment.

Subject (*d*) — Design of Standard Fireproof Sub-station Building of 1000 kw. capacity.

Your Committee started work early in the year and the subjects to be considered were assigned to the following Sub-committees:

Subject (*a*) — Committee as a whole.

Subject (*b*) — C. F. Bedwell, *Chairman,* and H. G. Throop.

Subject (*c*) — R. C. Bird, *Chairman,* and L. C. Datz, Terance Scullin.

Subject (*d*) — J. H. Frank, *Chairman,* and F. H. Miller, W. H. Roberts, H. G. Salisbury.

A general committee meeting was held at the Association rooms in New York City on July 7, 1915, attended by Messrs. Bedwell, Bird, Frank, Roberts, Salisbury and Throop. The reports of the several sub-committees were presented and approved as follows:

GENERAL SPECIFICATIONS AND FORM OF CONTRACT FOR RAILWAY STRUCTURES

The Form of General Specifications and Form of Contracts was revised somewhat in the manner of arrangement. The "Agreement" portion of the form was greatly shortened and made more general by eliminating certain paragraphs from the "Agreement" portion, as presented at the 1914 Convention, and embodying those paragraphs in the portion of the form designated as "General Conditions of the Contract."

Certain other changes have been made in the form so as to better protect the owner in case of action for damages in the matter of Liens and Claims under Workmen's Compensation Acts.

The revised form is submitted herewith for adoption as a Recommended Specification. Your Committee also recommends that this subject be further considered by the ensuing Committee.

GENERAL SPECIFICATIONS AND FORM OF CONTRACT FOR RAILWAY STRUCTURES

(Submitted for Adoption as a Recommended Specification*)

Proposal Sheet

All Contractors, in estimating on the work hereinafter described, shall be required to submit proposals as follows, and they shall, before submitting said proposals, thoroughly familiarize themselves with the site, grades and the nature and amount of all work that is to be executed, and likewise all Local Laws, Ordinances, or regulations appertaining thereto. Any assertion that there was any misunderstanding in regard to the nature or amount of work to be done will not be considered.

.....
.....
.....
.....

Here describe how the proposal is to be made, lump sum, alternates, etc,

All Plans and Specifications shall be returned (marked for identification), with proposals or same will not be considered.

The owner reserves the right to accept or reject any or all proposals submitted.

Lump sum proposals shall be submitted as above stated, also the following unit prices for additions to or omissions from the work to be contracted for, shall be submitted with proposal, or same will be considered void:

.....
.....
.....
.....

Here state the several items for which unit prices are desired,

Also, all other unit prices required for the various work specified or shown on plans shall be furnished to the Engineer upon his request.

It being understood that the above unit prices shall be based upon the various classes of work as herein specified, and shall conform to same in every respect.

All proposals for the work shall be submitted at the office of.....
.....
.....
not later than twelve o'clock noon, ..., 19...

CONTRACT

This agreement made this ..... day of ..... in the Year of Our Lord, one thousand nine hundred and ..... (19...)

*See page 351 for action of Committee on Standards.

between .....
.....
(hereinafter called Contractor) party of the first part, and .....
..... Company,
a corporation of the State of ..... (hereinafter called Owner) party of the second part;

WITNESSETH: That the said parties hereto have mutually bargained and agreed, and by these presents do mutually bargain and agree to keep, observe and perform all and singular, the stipulations, undertakings and agreements hereinafter specified; each party agreeing as to the matters and things said party is to do.

First.— Owner proposes to have built and constructed for its use and purposes .....
.....
.....
.....

Insert title, description of the work as used in General Conditions, Specifications and upon drawings,

.....
situated at .....
in the State of .....

Second.— The Contractor is to furnish all the material, apparatus, scaffolding, utensils and transportation of every description and do all the labor and everything required for said work in the construction and completion of the work described in the First Paragraph and in all respects according to the drawings hereto annexed, identified by the signature of the parties hereto, or herein described, and the following requirements, general conditions and specifications, annexed to and forming a part of this agreement.

Third.— Said Contractor is to commence work herein required ..... and complete the same on or before the ..... day of ..... in the Year of Our Lord, one thousand nine hundred and ..... (19...).

Fourth.— The time for the full performance and completion of the contract is a matter of essential importance to the said Owner and required by it in its business, and upon which various enterprises and transactions are dependent, and it has been bargained and agreed by and between it and the said Contractor that any delay beyond the time herein specified for the completion of the work herein contracted to be done by the said Contractor will cost the said Owner a sum of ..... per day; and it is therefore expressly agreed in consideration thereof, that from the balance of the sum owing said Contractor upon the completion of this contract, there shall be retained by said Owner as and for compensation for such delay a sum of ..... dollars for each day in excess and beyond the time herein limited; provided, however, that if said Contractor shall finish and complete said work on or before the ..... day of

..... next, said Owner shall and will pay said Contractor an additional sum to said contract price equal to ..... dollars for each day before said limited time the same is finished as aforesaid.

Fifth.— All work to be done and material furnished under this agreement shall be subject to the inspection of and performed to the entire satisfaction of the duly appointed Engineer of the Owner (hereinafter called Engineer), and no money shall at any time become payable in pursuance of this agreement until a certificate shall have been given by said Engineer to the effect that said Contractor is entitled to such payment under the provisions of this agreement. It is understood that the said Engineer may act herein by his duly appointed Assistant or Representative.

Sixth.— Said Owner is to pay said Contractor for the said work in the installments and manner hereinafter specified, ...
.....
.....
.....
.....

Here insert the amount of contract sum, and agreed upon unit prices for additions and omissions, if any,

Seventh.— The Owner shall pay to the said Contractor the said sum so specified in manner following, that is to say: Within ..... days after the close of any calendar month an approximate estimate shall be made by the Engineer of the said Owner of all the work performed and the material furnished for said months, and the amount thereof based upon the said contract price less ..... per cent, to be forthwith paid to the said Contractor; and within ..... after the final completion of all the work to the entire satisfaction of the said Owner, the balance owing to said Contractor shall be paid to said Contractor in cash.

Eighth.— This agreement, the general conditions of the contract, the specifications and the drawings are intended to fully coöperate and complement each other; and the Contractor hereby represents that prior to the execution of this Agreement he has examined in detail on the ground the location mentioned herein and indicated on the drawings, and that he has fully examined the drawings and has read each and every clause and section of this agreement; the general conditions of the contract, and the specifications and has had full opportunity to consider the same and all other matters which can in any way affect the work under this agreement and make necessary investigations relating thereto and he agrees that he will not make any claim for, or have any right to damages or an extension of time for completion of the work, or any other concession, because of any misinterpretation or misunderstanding of this agreement, the general conditions of the contract, the specifications or of the drawings, or because of any lack of information.

All work that may be called for in the specifications and not shown on the plans, or shown on the plans and not called for in the specifications, shall be executed and furnished by the Contractor as if described in both these ways; and should any work or material be required which is not denoted in the specifications or plans, either directly or indirectly, but which is nevertheless necessary for the proper carrying out of the intent thereof, the Contractor is to understand the same to be implied and required and shall perform all such work and furnish any such material as fully as if they were particularly delineated or described.

And to the faithful performance and fulfillment of all and singular the above mentioned stipulations, undertakings and agreements, said parties hereto do hereby bind and oblige themselves and their legal representatives each of the other and the legal representative of such other.

IN WITNESS WHEREOF, the said parties have caused these Presents to be properly executed on behalf of each; dated the day and year first above written.

..... COMPANY,

By

President.

ATTEST:

Approved:

.....

As to form:

..... *Secretary.*

GENERAL CONDITIONS OF CONTRACT

WORK COMPLETE:

1. These General Conditions and specifications are intended to embrace the entire work complete and ready for use, and all the work included in any contract that may be made for the construction of same, whether for the whole or a part of the work, shall be governed by these General Conditions and specifications. These General Conditions apply to each and every department or branch of the work.

CONTRACT DRAWINGS:

2. The following drawings shall be considered as forming a part of the contract:

No of Drawing *Title* (*Latest date on Drawing*)

ADDITIONAL DRAWINGS:

3. Additional detail and working drawings will be furnished in exemplification of the foregoing from time to time as they may be required; and it is distinctly understood and agreed that all such

additional drawings shall be considered as virtually embraced within and forming a part of the contract.

WORKING AND SHOP DRAWINGS:

4. The Contractor shall make all working or shop drawings which may be required in addition to the contract drawings, or in addition to such other drawings as the Engineer may issue in amplification of such contract drawings, as explained above. All working or shop drawings shall be submitted in duplicate to the Engineer for his approval, which approval shall be indicated by his countersigning one set of such working or shop drawings and returning the same to the Contractor. Should the working or shop drawings not be approved by the Engineer then the Engineer shall return one set of such working or shop drawings with the necessary correction and changes indicated thereon; and the Contractor must make such corrections and changes, and again submit drawings in duplicate for the approval of the Engineer; and no work called for by said working or shop drawings shall be done until the approval of the Engineer be obtained, which must be given or refused within twenty (20) working days after delivery to him at his office of such drawings in duplicate. Immediately upon final approval of such working or shop drawings by the Engineer, the Contractor shall furnish the Engineer with four additional copies of such approved drawings.

INTERPRETATION OF DRAWINGS:

5. Where discrepancies or omissions occur in drawings or explanations are required the matter shall be referred to the Engineer for final interpretation before proceeding with the work.

COMPLIANCE WITH LAW:

6. The Contractor shall familiarize himself with, and comply with all the City, Local, Special or State Ordinances, Laws or Regulations, in relation to the work, and all such Ordinances, Laws and Regulations shall be considered as forming a part of these General Conditions.

PATENT RIGHTS:

7. In the event of any suit or suits being brought against the Owner for the infringement of any letters patent of the United States by reason of the use of any invention, device, design, or apparatus furnished under the terms of this agreement the Contractor agrees that he will protect, indemnify and save harmless the Owner from and against all cost, damage, loss or expense which the Owner may incur or undergo by reason thereof.

BOND:

8. Said Contractor further agrees that at the time of the execution and delivery of this agreement and before the taking effect of the

same the said Contractor shall and will furnish and cause to be made, executed and delivered to the said Owner his bond or bonds in the sum of ..... dollars with sufficient surety satisfactory to said Owner conditioned for the faithful performance and carrying out to the perfect satisfaction of said Owner of all the stipulations, undertakings, contracts and agreements herein contained, and to indemnify, protect and save harmless the Owner from any and all damages, demands, costs or expenses incurred for or on account of or by reason of any liens, claims or demands whatsoever, either for material or from laborers, mechanics or others, or from any suit, action, claim, demand or damage arising from accidents including death to any person or persons whether employed upon said work or not; or from any injury or damage to any person or property occasioned by said Contractor or person acting for or under said Contractor; so that the said Owner shall and will be saved and forever held harmless from, by reason or on account of anything done or permitted to be done by said Contractor, or any person or persons acting for said Contractor, or any matter or thing which may be improperly omitted to be done under said Contractor, by any person or persons acting for said Contractor.

DEFECTIVE WORK AND MATERIAL:

9. The Contractor shall immediately take away and remove any material deemed defective by the Engineer which has been furnished for use in the performance of said work; either before or after such material is put in place, and shall furnish in the place and stead thereof, suitable material; and shall in like manner do over in a proper and satisfactory manner any work which in the opinion of the Engineer was imperfectly done, notwithstanding that such work and materials may have been previously overlooked by the Engineer and accepted or estimated for payment. Notice as to such material or such work from the Engineer of the said Owner specifying wherein the defect, improper or unsatisfactory material or work consists shall be deemed sufficient notice to said Contractor.

The expense necessarily incurred due to any such requirements herein stated shall be borne solely by the said Contractor.

CHANGES:

10. In case the said Owner shall desire any changes in either the work or material, it shall be at liberty to have the same made, and said Contractor does hereby agree to make such changes. Such changes shall only be on the written order of the Engineer of the said Owner; and if the same involve any additional time, material or labor, such order shall so state the same and the amount of cost to be paid therefor in addition to the aforesaid contract price; also the extension of the time limit to be allowed for the completion of the entire contract shall be so stated in said order; and should the same require any less

time, material or labor the same shall in like manner be specified in said order and the amount of payment to be abated therefor from the said contract price shall be likewise therein specified; also the deduction from the time limit set for the completion of the entire contract shall be likewise so stated in said order.

All additions to, or deductions from, the contract price shall be in the same ratio as the work added or subtracted bears to the entire work embraced in the contract.

The price for such work shall be determined by the Engineer who may set a lump sum price or direct that agreed upon unit prices shall be used in computing the sum to be added or deducted from the contract price as the case may be.

If the Contractor shall decline or fail to perform such work or furnish such extra material as authorized by the Engineer in writing, as aforesaid, the Owner may then arrange for the performance of the work in any manner it may see fit, the same as if this agreement had not been executed, and the Contractor shall not interfere with such performance of the work.

UNAVOIDABLE DELAYS:

11. It is further agreed and understood by and between the parties hereto, that in case delay be occasioned the said Contractor from strikes of workmen, lock-outs in the shops where the material is produced, or strikes upon the railroads interfering with the transportation of materials; or delay occasioned by flood, fire or disaster, then and in every such case the delay incident to said strikes, lock-outs, flood, fire or disaster, shall be allowed the said Contractor and not included as a part of the time in which said Contractor is to finish and complete said contract as herein specified.

OWNER'S OBLIGATION:

12. In case the Owner should fail to furnish any material or thing on its part to be furnished or supplied the said Contractor for the finishing and completing of the said contract, and such failure shall continue after ..... days written notice from said Contractor to said Owner of such failure, that then and in such case the number of days said failure shall continue after the expiration of ..... days after said notice, shall be allowed to the said Contractor as additional time for the completion of said contract.

LIENS:

13. Said Contractor shall and will discharge the said work, material and land whereon the same are erected from any and all lien, claim or demand from any person or persons whomsoever, so that the said Owner shall and may have, possess and enjoy the same, free from any and all liens, claims or demands of any other person or persons whomsoever claiming by, through or under said Contractor.

INDEMNITY:

14. The work in every respect shall be at the risk of the Contractor until finished and accepted and said Contractor shall and will indemnify, protect and save harmless the said Owner from any and all claims, costs, suits, demands, compensation, liability, damages or proceedings whatsoever for or on account of any accident, including death to any person or persons, whether working for the said Contractor or otherwise however; and likewise for any claim, suit, demand or damages for or by reason of any injury to the Owner's or adjacent property caused or occasioned by any act or omission of said Contractor or persons acting for him.

The Contractor shall maintain such liability insurance as will protect him from claims under workmen's compensation acts and from any other claims for damages for personal injury, including death, which may arise from and during operations under this agreement and contract. Certificates of such insurance shall be filed with the Owner, and shall be subject to its approval.

INSURANCE:

15. The Contractor shall from the commencement until the completion and acceptance of the work, maintain insurance jointly in his and the Owner's names in such amount as the Engineer may specify, not exceeding ..... dollars, against all damage by fire or lightning, tornadoes or other causes and shall submit policy to Owner for approval.

SUB-CONTRACT:

16. This contract, or any part thereof, on the part of said Contractor shall not be assigned or transferred to any other person or persons whomsoever (except for the delivery of materials), without consent of the Engineer, given in writing. Such consent does not release or relieve the Contractor from any of his obligations and liabilities under this agreement.

OTHER CONTRACTORS:

17. Wherever work being done by the Owner's forces or by other Contractors is contiguous to work covered by this agreement, the respective rights of the various interests involved shall be established by the Engineer, to secure the completion of the various portions of the work in general harmony.

ORDER OF COMPLETION:

18. The Contractor shall complete any portion or portions of the work in such order of time as the Engineer may require.

The Owner shall have the right to take possession of and use any completed or partially completed portions of the work, notwithstanding the time for completing the entire work or such portion may not have

expired; but such taking possession and use shall not be deemed an acceptance of the work as taken or used, or any part thereof.

If such prior use increases the cost of or delays the work, the Contractor will be entitled to such extra compensation or extension of time, or both, as the Engineer may determine.

EXPEDITING WORK:

19. Should the Contractor fail or neglect to furnish either sufficient workmen or material, or both, for the efficient and reasonable performance in due time of the work herein provided, and such failure and neglect shall continue for a space of ..... days after the service by the Owner on the Contractor of a written notice, specifying wherein such failure or neglect consists, then and in such case said Owner may take possession of all materials, scaffolding, apparatus and utensils on the premises and supply such workmen or materials, or both, and complete the work and the cost and expense incurred by said Owner therefor may be deducted from any sum due or owing or which there may thereafter become due or owing under this contract, and no money shall be payable to said Contractor until all of said cost and expense is paid and satisfied to said Owner. In case such cost and expense exceeds the sum due or to become due under this contract, said Contractor will pay said Owner such excess cost in cash.

Instead of supplying such workmen or material, or both, said Owner may at its option at the end of said ..... days, give notice in writing to Contractor that the Contractor's right to continue said work on this contract has ended, and said Owner may engage some other person or persons to do the same at the cost and expense of said Contractor, using for that purpose any of said contract price remaining; any cost in excess thereof the said Contractor is to pay said Owner. If there should remain any of said contract price after paying said Owner such cost and expense, it shall be paid to said Contractor. The remedies and provisions herein reserved by the said Owner are in addition to any legal remedies possessed by it, and are to be deemed and taken as cumulative remedies, and not to exclude any other lawful remedies not herein specified.

OWNER'S PRIVILEGE TO ANNUL CONTRACT:

20. The Owner shall have the right at any time, for reasons which appear good and sufficient to the Owner, to annul this contract upon giving thirty (30) days' notice in writing, to the Contractor, in which event the Contractor shall be entitled to the full amount of the estimate for the work done by him under the terms and conditions of this contract up to the time of such annulment, including the retained percentage. The Contractor shall be reimbursed by the Owner for such expenditures as in the judgment of the Engineer are not otherwise compensated for, and as are required in preparing for and moving to and from the work; the intent being that an equitable

settlement shall be made with the Contractor, and the Contractor, if notified to do so by the Owner, shall promptly remove any part or all of his equipment and supplies from the property of the Owner, failing which the Owner shall have the right to remove such equipment and supplies at the expense of the Contractor.

NOTICE TO CONTRACTOR:

21. Any notice to be given by the Owner to the Contractor under this contract shall be deemed to be served if the same be delivered to any office used by the Contractor, or to his agent or foreman at or near the work, or deposited in the post office, addressed to the Contractor at his last known place of business.

PERMITS:

22. The Contractor shall obtain and pay for all temporary permits, and shall also pay all inspectors' fees, or any other charges from City, District or State Office.

LINES AND LEVELS:

23. The Contractor shall lay out his work, including all lines and levels required, and shall also locate all openings and shall be responsible for all measurements. During the progress of the work the Owner will give, through the Engineer, to the Contractor, suitable points, marks or benches, indicating the lines and grades of the work, such points or bench marks to be established at such intervals as the Engineer deems necessary for the Contractor to perform his work. The principal lines and grades are to be given by the Engineer. The stakes and marks given by the Engineer shall be carefully preserved by the Contractor, who shall give to the Engineer all necessary assistance and facilities for establishing benches and plugs and for making measurements.

SUPERINTENDENCE:

24. The Contractor shall attend to every part of the work personally, or through a competent superintendent, who must always be kept on the work, and receive instructions in the absence of the Contractor.

WORKMEN:

25. Any and all workmen employed on the entire work shall receive the prevailing rate of wages for their work consistent with their trade or occupation, and shall not be required to work more than the standard hours of work agreeable to above, excepting in the case of extraordinary emergency, or where life or property is endangered.

The Contactor shall employ only competent, skillful and faithful men to do the work. Whenever the Engineer shall notify the Contractor in writing that in his opinion any man on the work is incompetent, unfaithful or disorderly, such men shall be discharged from the work and shall not again be employed on it.

CONNECTIONS WITH OTHER WORK:

26. The Contractor shall consult the Engineer for any work other than that called for in the specifications, or shown on drawings, and shall prepare for and do all cutting and patching up in connection with the installation of same.

EASY INSPECTION:

27. The Engineer shall be furnished with every reasonable facility for ascertaining whether the work is in accordance with the requirements and intention of this contract.

REFUSE MATERIALS:

28. The Contractor during the progress of the work and as may be directed by the Engineer, shall remove all refuse materials and rubbish which may accumulate by reason of his work, and on completion shall leave his work clean and whole.

ACCEPTANCE OF MATERIALS:

29. It is understood and agreed that the final inspection and acceptance of the work shall take place at the structure after erection, and that any inspection and acceptance of material and workmanship at mills, shops, or elsewhere, that may be made to facilitate the progress of the work, shall not preclude rejection at the site of the work if the same be found unsuitable.

TREES:

30. The Contractor shall properly box and protect against damage all trees and shrubbery that are not deemed necessary to be removed by the Engineer.

WATCHMAN:

31. The Contractor shall employ and keep night and Sunday watchmen on the premises from the commencement to completion of the work, and shall also hold himself responsible for the safety of the premises by day and night.

ABSENCE OF CONTRACTOR:

32. When the Contractor is absent from any part of the work where it may be necessary to give instructions, orders will be given by the Engineer to, and shall be promptly obeyed by the Superintendent or overseer of the Contractor who may have charge of the particular work in relation to which the orders are given, and a confirmation in writing of such orders will be given to the Contractor by the Engineer if so requested.

CARE OF FINISHED WORK:

33. During the progres of construction the Contractor shall protect all work from injury or defacement, and particular care shall be taken of all finished parts, which shall be covered where required for their thorough protection, and same shall be maintained until completion, and should materials or work become damaged, same shall be immediately removed, replaced with new materials, and left perfect at completion, and the Contractor shall also furnish temporary heat and light whenever necessary or as directed by the Engineer.

OFFICE:

34. The Contractor shall furnish and erect, in a substantial manner, a frame office for use of the Owner's Engineers, about ..... . The roof and sides shall be weather and water-tight; same shall have long tables at ends, with drawers and cupboards under. The office shall also be provided with necessary heat and light.

TELEPHONE:

35. The Contractor shall also install a telephone as soon as the work is commenced, and maintain same until completion.

FENCING:

36. The Contractor shall protect all excavations adjoining property and public places by substantial fencing, and shall maintain same in good condition until ordered to be removed by the Engineer; same shall have sufficient doors in same in order to allow of frequent exits, strongly locked and secured, and with fixed ladders leading to same. The posting of any bills or placards on the fencing will not be permitted.

WATER:

37. The Contractor shall pay all costs or charges in connection with the supply of water to be used for all purposes until the completion of the work to be done and the same shall be ample at all times.

CONVENIENCES FOR MEN:

38. Necessary conveniences, properly secluded from public observation, shall be constructed and maintained by the Contractor at his own expense wherever needed for the use of the Contractor's employes, to the satisfaction of the Engineer and the sanitary authorities.

ADVERTISEMENT:

39. The Contractor shall not be allowed to place any sign on the premises until same has been approved by the Engineer.

SPECIFICATIONS FOR MATERIALS

QUALITY:

1. All materials used throughout shall be the best of their respective kinds, unless specified to the contrary, and samples of same shall be submitted whenever requested; also all models, patterns and templates required, and same shall be subject to the inspection and approval of the Engineer before any work is done or materials ordered.

OPTION:

2. When more than one kind of manufacture of a material is specified the option shall be with the Contractor. When one kind or "approved equal" is specified the choice shall be made by the Engineer, who may select an "equal" if requested by the Contractor.

CEMENT:

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SAND:

4. .....
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GRAVEL:

5. .....
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BROKEN STONE:

6. .....
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PEBBLES:

7. .....
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CRUSHER DUST:

8. .....
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CINDERS:

9. .....
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REINFORCING STEEL:

10. .....
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STRUCTURAL STEEL:

11. .....
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ETC.

DEMOLITION

Excavations, Mortar, Concrete, Masonry, Brick Work, Cut Stone Work, Terra Cotta Work, Iron and Steel Work, Sheet Metal Work, Lumber and Mill Work, Painting and Glazing, Plastering, Roofing, Hardware, Plumbing, Heating, Lighting, etc.

EXPANSION OF CONCRETE

The Sub-committee assigned to Subject (*b*) presents their rather elementary report for discussion and expression from the Convention as to what special features will be desirable for future study. This report is shown herewith.

PROPER PROVISION FOR EXPANSION AND CONTRACTION IN CONCRETE STRUCTURES, TOGETHER WITH PROVISIONS FOR WATERPROOFING SUCH ARRANGEMENTS.

RESTRAINED STRUCTURES:

When a reinforced concrete structure is restrained by outside forces and when that structure contains steel reinforcement that is not evenly distributed throughout a large mass of concrete (heavy reinforced concrete wall where practically all the steel is concentrated on the tensile side of wall) then the stresses resulting from a drop in temperature equal to about 15 deg. Fahr. will stress the concrete sufficiently (in tension) to cause excessive cracks in the opposite side of the wall to that containing the main reinforcement. To prevent these contraction or shrinkage cracks from being noticeable (minute cracks will still be there) about 0.4 per cent of steel reinforcement placed near the exposed face of the wall will suffice. In practice this amount of steel will do the work but theoretically almost twice this percentage is required.

As an example of finding the amount of steel necessary to minimize the shrinkage cracks assume a wall or slab to be 12 in. in thickness. Then the amount of steel required in the wall would be 12 in. (thickness) x 12 in. (width or length) or 144 sq. in. x 0.004 = 0.576 sq. in. of steel per foot width or length of slab or wall.

No amount of steel will entirely eliminate cracks but the more steel used the smaller will be the cracks. The steel should be placed about 2 in. from the surface that is exposed to the temperature changes to be effective. Small roads spaced close together or a mesh should be used rather than large rods spaced far apart that would give the same area of steel. (See Fig. 1.)

UNRESTRAINED STRUCTURES:

In reinforced concrete structures which are free to expand and contract the stresses from shrinkage and temperature changes are due to the mutual action of both the concrete and steel. These stresses have been proven to be of so little importance that they may be ignored in practice. In this type of structure the stresses from temperature alone are negligible because concrete and steel have practically the same coefficiency of expansion. They both expand or contract about sixty-five ten millionths of their length for each Fahrenheit degree change of temperature.

Therefore, a wall built in 30 ft. lineal sections subjected to a change of 50 deg. (Fahr.) rise in temperature will expand as follows:

$$30 \times 0.0000065 \times 50 = .0098 = \text{about } \tfrac{1}{8} \text{ in.}$$

SLAB BRIDGES:

Reinforced concrete slab bridges should be limited to spans of about 35 ft. This is because it is difficult to allow for free expansion the

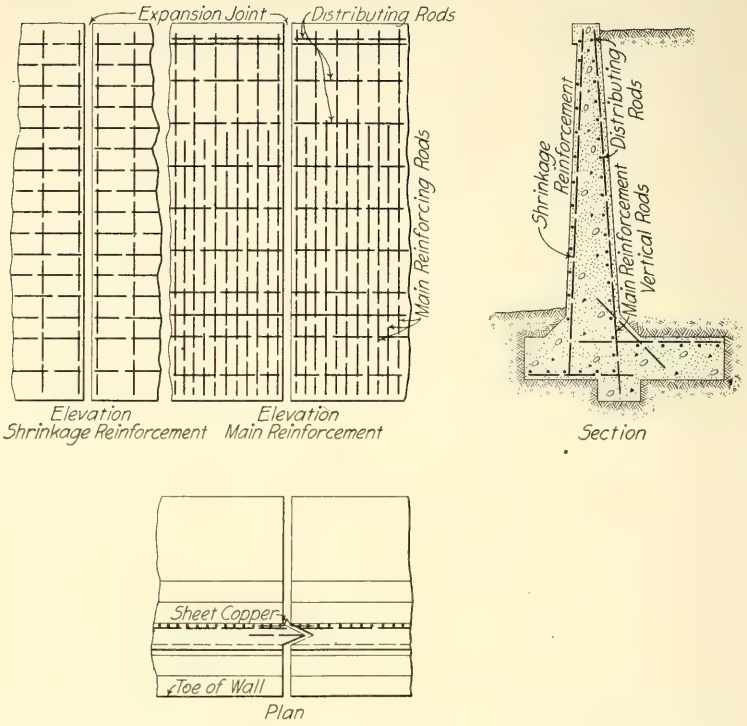


FIG. 1. EXPANSION JOINT IN A REINFORCED CONCRETE RETAINING WALL (CANTILEVER TYPE).

way that it is done in a steel bridge. The width of a slab bridge rarely exceeds 50 ft. and therefore there need be no provision for expansion in this case. If in a slab bridge it is necessary to provide for expansion and contraction in order to maintain the true alignment of tracks a longitudinal joint similar to the one shown in Fig. 2 might be used.

FENCES, RAILINGS, COPING WALLS, ETC.:

When a fence, railing or coping wall, etc. is restrained or is part of a restrained structure expansion joints should be provided about every 30 ft. Examples of such structures would be a long reinforced concrete fence or a fence, railing or coping on top of a retaining wall.

A railing, coping or parapet wall on an ordinary building need not be provided with expansion joints. In fact it would be useless to provide joints for same when there is not provision for expansion made in the roof of said building.

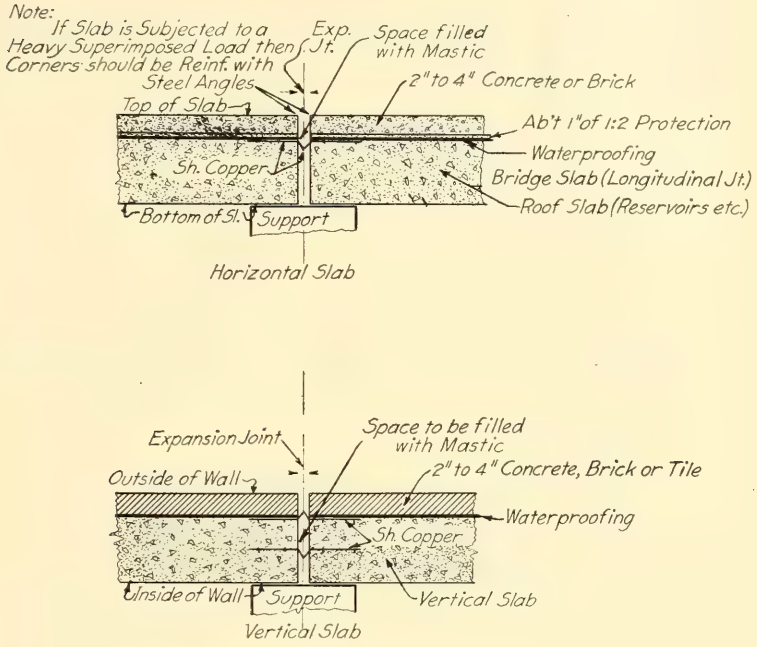


FIG. 2. WATERPROOFED EXPANSION JOINTS FOR SLABS (PLAIN AND REINFORCED).

TYPE OF JOINT:

Expansion joints in the ordinary retaining wall, parapet wall or fence may be either the rectangular or triangular tongue and groove type. These types of joints insure the wall against lateral movement that would throw same out of line.

The maximum distance that expansion joints should be spaced is 50 ft. (applies to restrained structure). This spacing will be ample for large, gravity retaining walls, etc.

When a wall is not several feet in thickness and is subjected to 50 deg. seasonal change of temperature, joints should be provided at about 30 ft. centers. Joints should always be placed near all corners or turns in a wall, and the corner or turn should be specially reinforced to take care of the greater strain.

To determine the size (width of opening) of joint in ordinary practice it is sufficient to do as follows:

Change in temperature is commonly taken to be 50 deg. and the coefficient of expansion for concrete and steel to be 0.0000065.

If the joints are spaced 30 ft. apart and the structure is free to move (unrestrained) then the gap of the joint might be as great as

$$50 \times 0.0000065 \times 30 = 0.00975 = \text{about } \tfrac{1}{8} \text{ in.}$$

If joints are 50 ft. apart

$$50 \times 0.0000065 \times 50 = 0.01625 = \text{about } 3/16 \text{ in.}$$

The above gives the maximum value, friction, etc. are neglected. (See Fig. 3.)

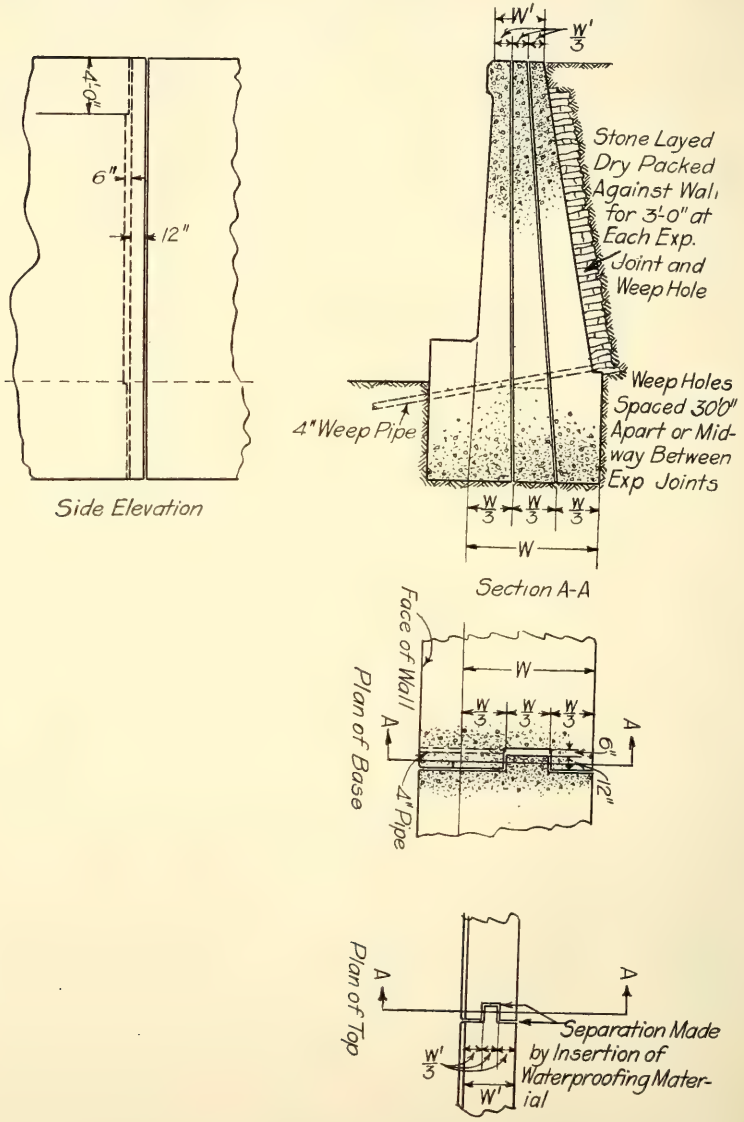


FIG. 3. SKETCH OF EXPANSION JOINT FOR PLAIN CONCRETE WALLS.

Expansion joints serve another purpose. (Referring particularly to gravity retaining walls.) They act as settlement joints, thus eliminating the danger of a wall-face being ruined with cracks caused by slight uneven settlement in the footings.

In a reinforced wall the steel will reduce shrinkage and contraction cracks to a minimum and the steel will hold a wall true to line and grade when a plain wall might settle. It is possible by proper reinforcing to erect considerable lengths of reinforced wall without expansion joints.

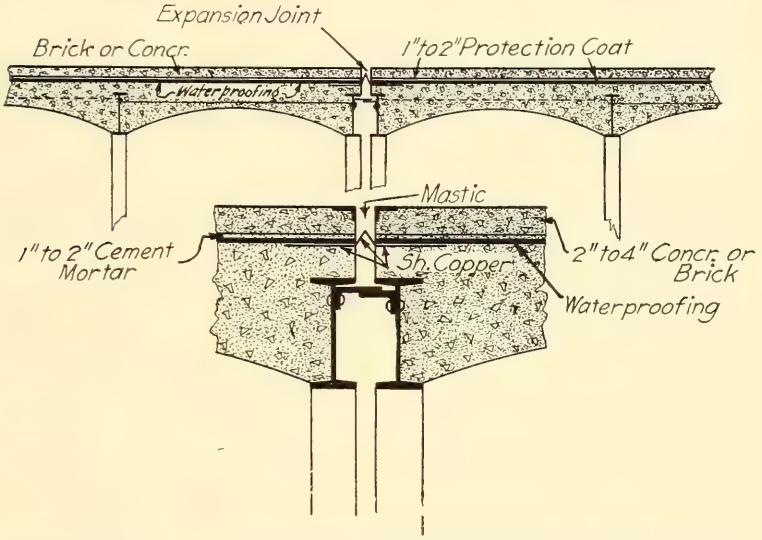


FIG. 4. SKETCH SHOWING A WATERPROOFED EXPANSION JOINT IN AN ARCHED ROOF OR SIDE WALL.

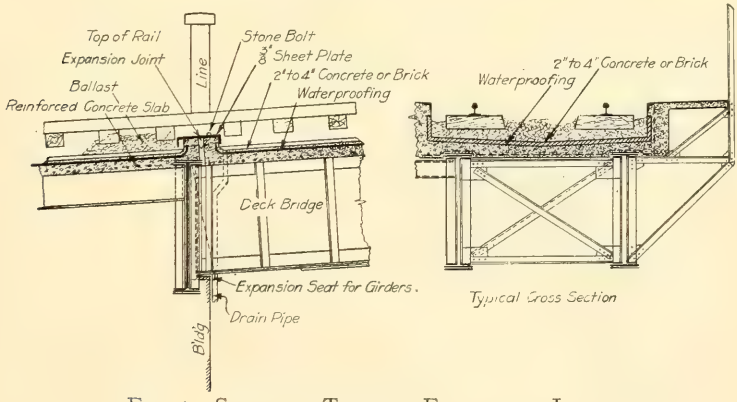
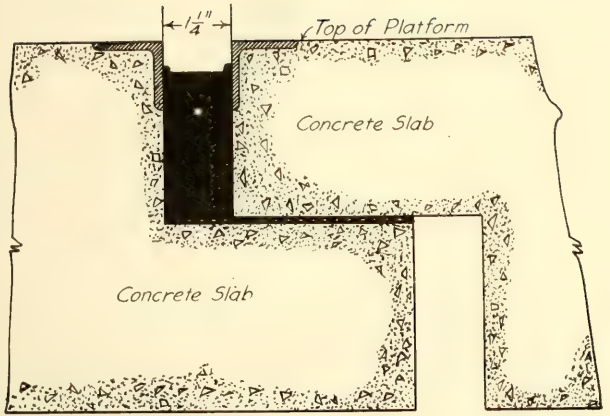
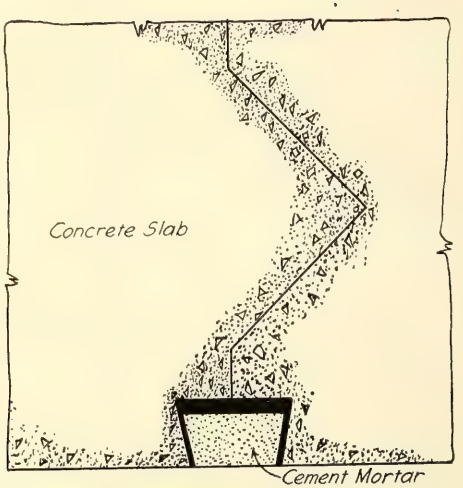


FIG. 5. SHOWING TYPE OF EXPANSION JOINT.



Section
Expansion Joint for Platform



Expansion Joint for Arch or
Retaining Wall

FIG. 6. EXPANSION JOINTS FOR PLATFORM AND ARCH OR RETAINING WALL.

Figs. 4 and 5 represent typical type of expansion joint and method of waterproofing same in the case of an arched roof or side wall and the deck type of bridge, respectively.

Fig. 6 represents types of waterproofed expansion joints that may be used for an arch or retaining wall and scheme for taking care of expansion and waterproofing of a platform slab.

Fig. 7 represents a method that may be followed in the case of a bridge slab.

Fig. 8 illustrates method of curing leaks in a bridge structure that have developed due to cracks caused by expansion and contraction.

Fig. 9 shows a general view of method used to provide for expansion and contraction in the roof of large reinforced concrete car house. Figs. 10 and 11 clearly show details of this very interesting case for both roof and side walls.

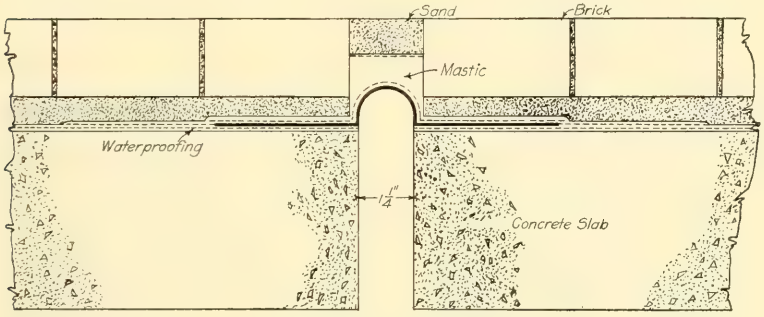


FIG. 7. METHOD OF WATERPROOFING BRIDGE SLAB EXPANSION JOINTS.

RULES FOR FIRE PROTECTION *

The Sub-committee assigned to give further consideration to the Fire Protection Rules, does not change the General Fire Rules as presented to the 1914 Convention and desires that those rules be approved by the Committee on Standards as a Recommendation.

The Sub-committee after studying all available rules, standards and blue prints on this subject found that they are in accord with the publications of the National Board of Fire Underwriters. It is, therefore, thought proper to print below extracts from the Building Code of the National Board of Fire Underwriters as they may apply to the many classes of construction employed in buildings of member companies, it being the desire of the Sub-committee that these recommendations receive full and free discussion on the floor of the Convention.

FIRE PROTECTION RULES AS RELATING TO HEATING APPARATUS

CHIMNEYS, SMOKE FLUES, AND GAS FLUES

1. All chimneys hereafter erected shall be of brick or stone laid in Portland cement mortar without addition of lime, reinforced con-

*Formally approved by both the Committee on Standards and 1915 Convention.

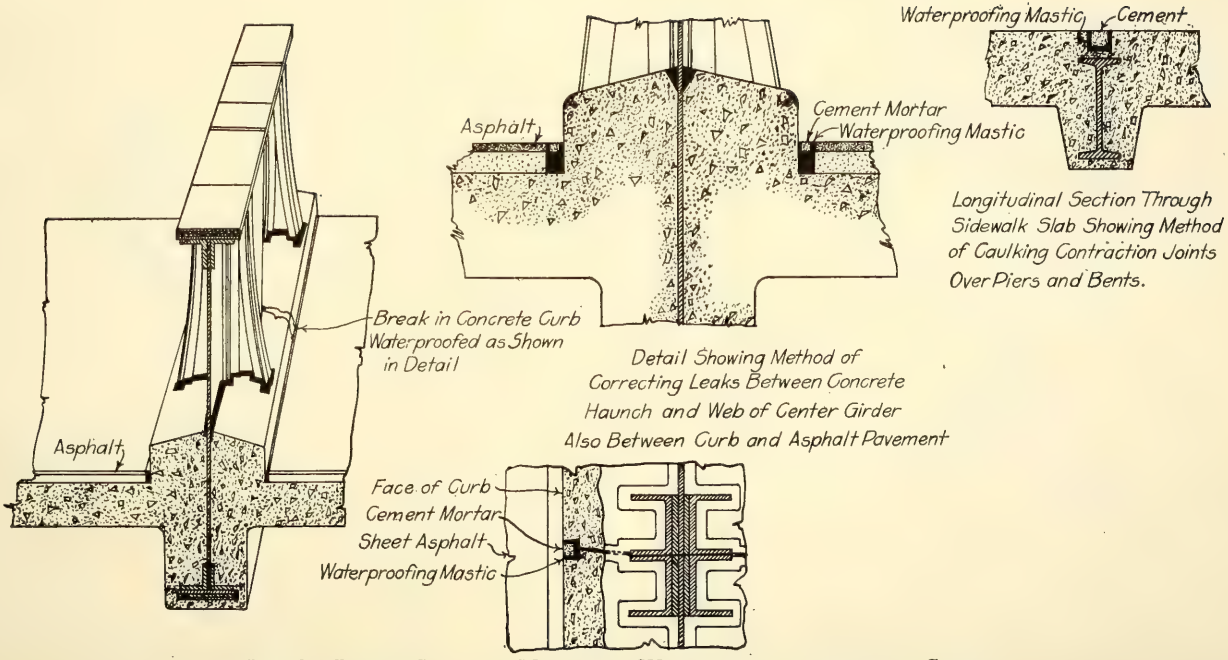

Waterproofing Mastic
Cement
Asphalt
Cement Mortar
Waterproofing Mastic
Longitudinal Section Through Sidewalk Slab Showing Method of Caulking Contraction Joints Over Piers and Bents.
Break in Concrete Curb Waterproofed as Shown in Detail
Asphalt
Detail Showing Method of Correcting Leaks Between Concrete Haunch and Web of Center Girder Also Between Curb and Asphalt Pavement
Face of Curb
Cement Mortar
Sheet Asphalt
Waterproofing Mastic

FIG. 8. DETAIL SHOWING METHOD OF WATERPROOFING BREAKS IN CURB.

crete or other approved incombustible material, extending at least three (3) feet above the point of contact with a flat roof or two (2) feet above the ridge of a pitch roof, and shall be properly capped with terra cotta, stone, cast iron, or other approved incombustible weather-proof material.

NOTE.—Portland cement mortar is very superior to lime mortar in resisting the action of heat and flue gases. The latter disintegrates in time, and is liable to fall out of the joints, thus producing a hole through which a fire is likely to originate.

2. The brickwork or reinforced concrete of the smoke flues of all boilers, furnaces, ovens, large cooking ranges, large stoves, and all flues used for a similar purpose shall be at least eight (8) inches in thickness. Walls of smoke flues used exclusively for ordinary stoves or open fires shall be not less than four (4) inches thick. Brick set on edge shall not be permitted in chimney construction.

3. Where two or more smoke flues are contained in the same chimney, the walls between the several flues shall be not less than four (4) inches thick. The walls of stone smoke flues shall be four

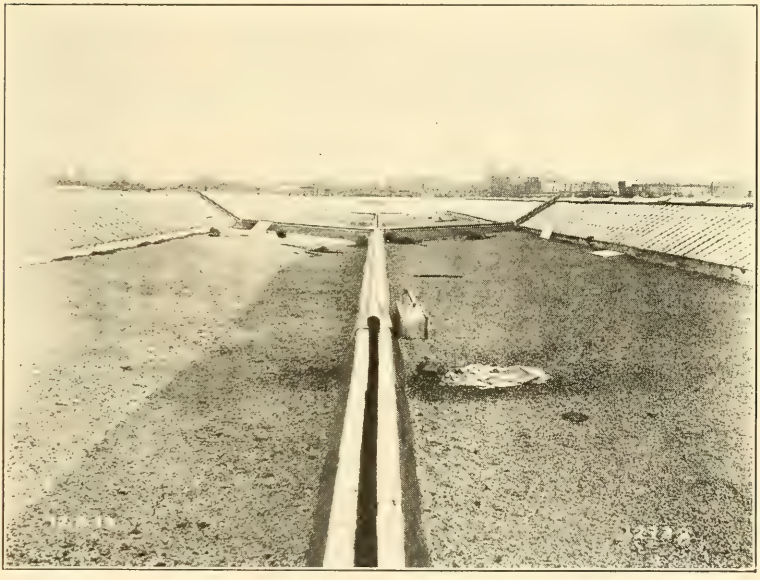
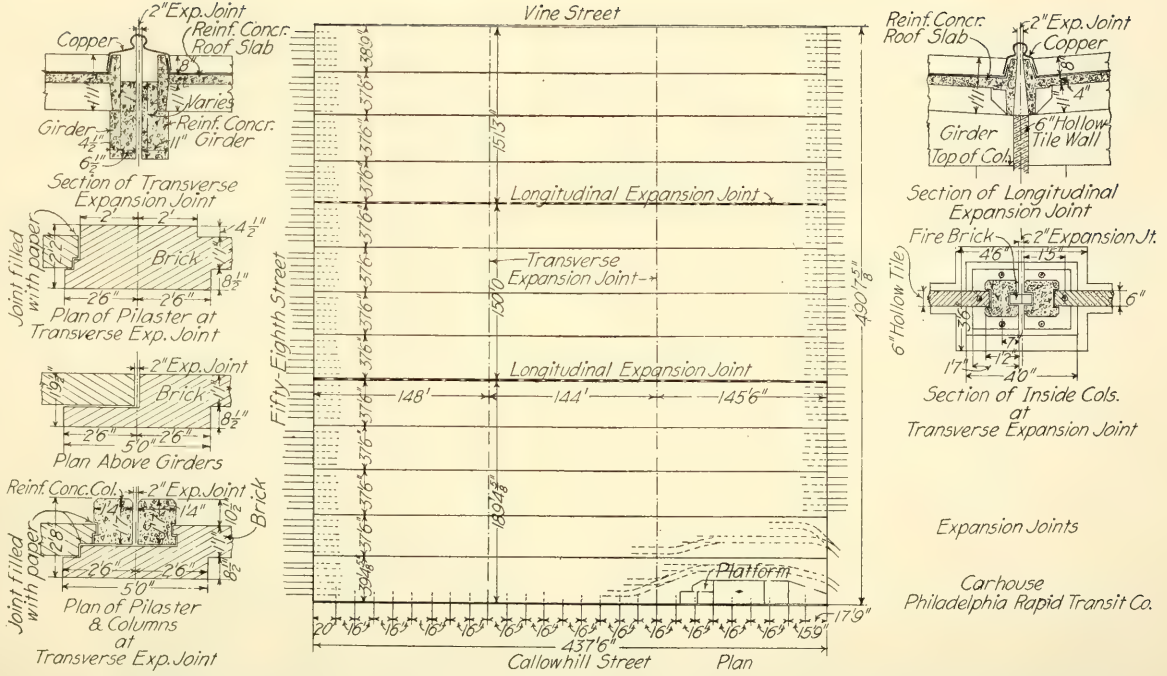


FIG. 9. METHOD OF PROVIDING FOR EXPANSION AND CONTRACTION IN ROOF OF CONCRETE CAR HOUSE.

(4) inches thicker than required for brick or reinforced concrete. No smoke flue shall have smoke pipe connections in more than one story of a building.

4. (*a*) Every smoke flue contained in a chimney hereafter erected shall have an area of at least sixty-four (64) square inches and, unless



Expansion Joints

Carhouse
Philadelphia Rapid Transit Co.

FIG. 10. SHOWING DESIGN OF EXPANSION JOINTS IN CAR HOUSE OF PHILADELPHIA RAPID TRANSIT CO.

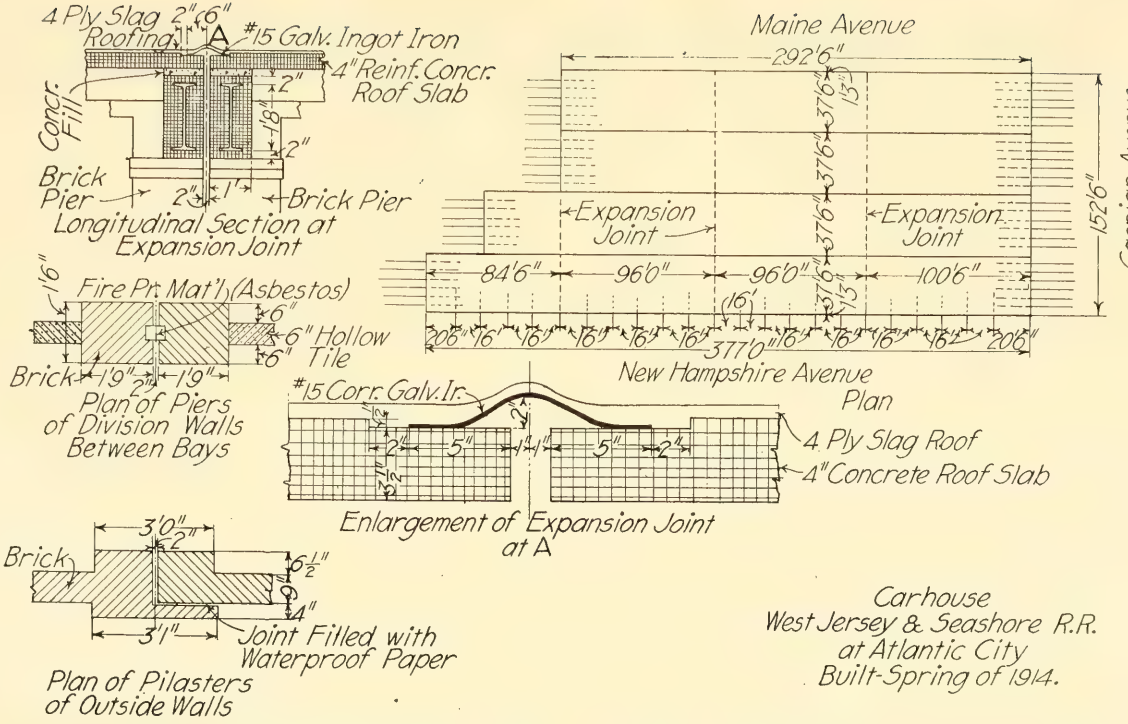


FIG. 11. SHOWING DESIGN OF EXPANSION JOINTS IN CAR HOUSE OF WEST JERSEY AND SEASHORE RAILROAD

required to be lined with fire brick, shall be lined with hard burned terra cotta or fire clay flue lining made smooth on the inside. The flue lining shall start from the bottom of the flue, or from the throat of the fireplace if the flue starts from a fireplace, and shall be carried up continuously the entire height of the flue. If the thickness of the masonry surrounding the throat be less than eight (8) inches in any part, the lining shall start at bottom of the lintel. The ends of the sections of all such lining tile shall be laid in cement mortar and the tile shall be built in as the flues are carried up.

(*b*) No parging mortar nor plaster shall be used on the inside of any fireplace, chimney, or flue.

NOTE.—While walls four (4) inches thick and lined are permitted for chimneys serving as flues where high temperatures are not maintained, a minimum wall thickness of eight (8) inches is strongly recommended, especially in localities subject to long, severe winters, and where continuous hot fires are a necessity.

5. In every building, where one or more smoke flues start from the basement or lowest story, at least one such smoke flue shall have an internal cross-sectional area of at least ninety-six (96) square inches and shall start at least three (3) feet below the ceiling.

6. In no case shall a chimney be corbeled more than eight (8) inches from the wall, and such corbeling shall consist of at least five courses of brick. Piers which support chimneys shall start from the foundation on the same line with the chimney breast. They shall be not less than twelve (12) inches on the face and shall be properly bonded into the walls. No chimney shall rest upon, nor be carried by woodwork. No combustible furring or sheathing shall be placed against any smoke flue or chimney breast.

7. The walls of flues used only for gas burning appliances shall be of brick or concrete at least four (4) inches thick and lined as required in Par. 4. Where two or more such flues are contained in same chimney, the walls between the several flues shall be not less than two thicknesses of the tile lining with joints broken, except that at least every third partition shall be not less than four (4) inches thick of brick or its equivalent, and bonded into the walls. Not more than one appliance or utensil in which gas is used as fuel shall be connected to a single flue, nor shall any such appliance or utensil be connected to any flue to which a smoke pipe is connected.

8. The smoke flue of every high pressure steam boiler and every appliance producing a corresponding temperature in the smoke flue shall, if built of brick, stone, reinforced concrete or other approved masonry, be lined on all sides with not less than four (4) inches of fire brick laid in fire mortar for a distance of at least twenty-five (25) feet from the point where the smoke connection of the boiler enters the flue.

9. Interior vertical smoke stacks or flues for steam boilers or other furnaces, and similar heating devices producing a corresponding temperature, may be of metal not less than No. 10 U. S. Gauge, properly

riveted, jointed, and braced at intervals of at least twenty (20) feet. Such stacks shall either be enclosed by approved masonry walls not less than eight (8) inches thick with an air space of at least four (4) inches between lining and wall; or if such stacks or flues are not enclosed with masonry they shall have a clearance from all combustible material of not less than one-half the diameter of the stack, but not less than twenty-four (24) inches, unless the combustible material be properly guarded by loose fitting metal shields, in which case the distance shall be not less than twelve (12) inches. Where such a stack passes through a wooden framed roof, it shall be guarded by a galvanized iron ventilating thimble extending from at least nine (9) inches below the underside of the ceiling or roof beams to at least nine (9) inches above the roof, and the ventilating thimble shall have a clearance of not less than eighteen (18) inches, except that for stacks for low grade furnaces such as hot air, hot water, and low pressure steam heating furnaces, etc., the clearance may be reduced to twelve (12) inches. Metal smoke stacks shall not be permitted to pass through floors. Smoke flues shall not be permitted inside of vent flues for ranges.

10. Exterior metal smoke flues for boilers, large cooking ranges, and similar heating devices, shall be of approved construction and supported on approved masonry foundations, and shall have a clearance of at least four (4) inches from the outside wall. Such flues having an area not exceeding two hundred fifty-five (255) square inches shall be constructed of not less than No. 16 U. S. gauge metal; if the area exceeds two hundred fifty-five (255) square inches the thickness of the metal shall be not less than No. 10 U. S. gauge.

11. The smoke flue of every smelting furnace and of every other similar device which heats the flue to an extremely high temperature, shall be built with double walls of thickness suitable for the temperature. There shall be an air space between the walls, and the inside wall shall be of firebrick not less than four (4) inches thick.

12. Chimneys of cupola-furnaces, blast furnaces, and similar devices, shall extend at least ten (10) feet above the highest point of any roof within a radius of fifty (50) feet, and no woodwork shall be within three (3) feet of any part of any such device or its chimney.

13. (*a*) When a building or structure extends more than ten (10) feet above the roof of an adjoining building or structure, the owner of the higher building, if requested in writing during its construction by the owner of the adjoining building or structure, shall at his own expense extend the adjoining flues of such adjoining building to the same height as the chimneys of his building, or shall supply sufficient flues connecting such adjoining flues with the chimneys of his building.

(*b*) All flue-holes when not in use shall be closed with tight-fitting metal covers.

Smoke Pipes

14. No smoke pipe shall pass through any floor, nor through a non-fireproof roof. Smoke pipes for large cooking ranges, hot air furnaces, low pressure steam or hot water boilers shall be not less than eighteen (18) inches below any wood lath and plaster or other combustible ceiling, unless at least the upper half of such smoke pipe is properly protected by one (1) inch or more of asbestos covering or its equivalent, or by a metal casing spaced two (2) inches from the upper half of the pipe. If so protected, smoke pipes shall be not less than nine (9) inches from any wood lath and plaster construction, woodwork or other combustible material. Smoke pipes from ordinary stoves shall be not less than nine (9) inches from any exposed woodwork.

15. Where a smoke pipe passes through a wood lath and plaster or other combustible partition or wall, a section of the partition or wall shall be removed and the smoke pipe so placed that no part of it shall be nearer than twelve (12) inches to any remaining combustible part of the partition. The section of the partition or wall so removed shall be replaced by approved fireproof material only, and an air space of at least two (2) inches shall be preserved on all sides of the smoke pipe.

Heating Furnaces and Appliances

16. High pressure steam boilers, ovens or furnaces in which fires are maintained producing a high degree of heat, shall rest on the ground, a trimmer arch, or a fireproof floor.

17. (*a*) Low pressure heating boilers, coal ranges without legs, and similar appliances where hot fires are used, shall rest upon fireproof foundations as above described or upon wooden floors if the floors are protected by a one-eighth (⅛) inch layer of asbestos building lumber, covered with not less than four (4) inches of masonry set in cement mortar. Such masonary shall consist of one course of four (4) inch hollow terra cotta, or of two courses of brick or terra cotta, at least one of which shall be hollow and be laid to preserve a free circulation of air throughout the whole course. Concrete may be substituted for a course of solid brick if desired. The masonry work shall be covered by sheet metal of not less than No. 26 U. S. gauge, so arranged as not to obstruct the ventilating passages beneath. Such hearths shall extend at least twelve (12) inches on the sides, back, and front of the furnace range or similar heating appliance; if solid fuel is used, the front extension shall be at least twenty-four (24) inches.

(*b*) All stoves or ranges with legs shall be set on incombustible material which shall extend at least twenty-four (24) inches in front when solid fuel is used.

(*c*) All low gas heating devices shall be placed on iron stands or the burner shall be at least six (6) inches above the base of the

devices, and metal guard plates placed four (4) inches below the burners, and all woodwork under them shall be covered with metal. Gas connections to such heating devices shall be made of metal pipes.

NOTE.—Solid brickwork will conduct heat quite freely. There are records of numerous fires starting by the ignition of wooden flooring underneath single layers of brick which supported furnaces or ranges in which hot fires were maintained. Hence the necessity of the double layer and air space.

18. Any woodwork or wooden lath and plaster partition within four (4) feet of the sides or back, or six (6) feet from the front of any such boiler, furnace, or heating appliance, shall be covered with metal shields or other incombustible material to a height of at least four (4) feet above the floor. This covering shall extend the full length of the boiler, furnace, or heating appliance, and to at least five (5) feet in front of it. Such metal shields shall be so attached as to preserve an air space behind them. In no case shall such combustible construction be permitted within two (2) feet of the sides or back of the heating appliance, or five (5) feet in front of same.

19. Heating boilers shall be encased on sides and top by incombustible protective covering not less than one and one-half (1½) inches thick, and the overhead clearance of such covered boilers and hot air furnaces shall be not less than fifteen (15) inches. Any woodwork within two (2) feet of the top of such boilers or furnace shall be protected by a loose fitting metal shield, but such shields shall not be placed so as to form concealed spaces.

NOTE.—It is recommended that the room or rooms in which boilers are located, shall be separated from other portions of the building by an 8 inch wall, having an approved fire door at each opening.

STOVES AND RANGES

20. No kitchen range or stove in any building shall be placed less than three (3) feet from any woodwork or wooden lath and plaster partition unless the woodwork or partition is properly protected by metal shields, in which case the distance shall be not less than eighteen (18) inches. Metal shields shall be so attached as to preserve an air space behind them.

21. No furnace, boiler, range or other heating appliance shall be placed against a wall furred with wood.

STEAM AND HOT WATER PIPES

22. No steam or hot water pipe shall be within one (1) inch of any woodwork. Every steam or hot water pipe passing through combustible floors, or ceilings, or wooden lath and plaster partitions, shall be protected by a metal tube one (1) inch larger in diameter than the pipe and be provided with a close-fitting metal cap on each side of the floor or partition. All wooden boxes, or casings enclosing steam or hot water heating pipes, or wooden covers to recesses in walls in which steam or hot water heating pipes are placed, shall be lined with

metal, and the pipes shall be kept at least one (1) inch away from the walls of the box. Steam and hot water pipe coverings shall be of incombustible material.

DESIGN OF FIRE PROOF SUB-STATION

The Sub-committee having this subject under consideration presents the following report and it is their earnest desire that a full discussion will be given same on the floor of the Convention in order that suggestions may be made for the guidance of future committees as your Committee recommends that this subject be considered again next year.

Report of Sub-Committee on Study for Standard Fire-Proof Sub-Station Buildings of About 1000 Kw. Capacity

Subjects and arrangements to be taken into consideration may be as follows with slight variations to suit special conditions:

1. *Site* — Depends on local conditions.
2. *Foundations* — Depends on local conditions.
3. *Basement* — Metal frames and sash, ribbed glass.
4. *Main Floor* — Fireproof constructed floor, concrete on ground if no basement. Walls of brick inside and outside. Two (2) inches of air space between inner and outer walls. Inside walls may be in colors. Metal frames and sash, ribbed glass. Good ventilation.

   Rotary Converters 2–500 kw.

   Space may be provided for third machine of same capacity.

   Compartments for oil switches and transformers of fire-proof material.

   Switchboard of standard construction.

5. *Roof* — Slag, tile or slate on top of fireproof roof depending on architectural results desired.

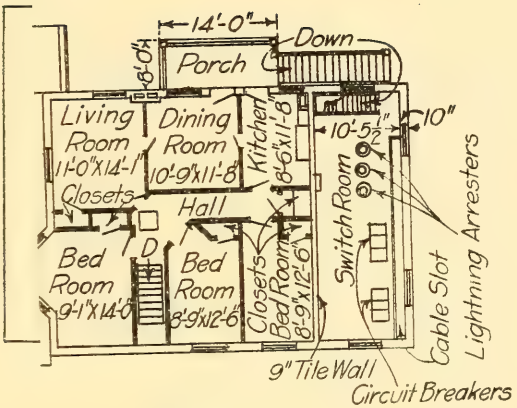
   Whole building of fireproof construction.

   All regulations of the fire underwriters should be observed for the protection of the property and lives of employes.

   Basement under certain conditions may be omitted and building also kept to minimum height and thus expense reduced, by making pits under apparatus in which they may be set while repairs are being made.

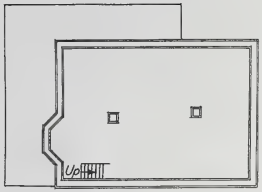
   It is found advantageous to incorporate ticket offices, baggage and freight accommodations and residences in connection with such sub-stations.

   Fig. 12 shows such a sub-station without showing extra space for a third machine.

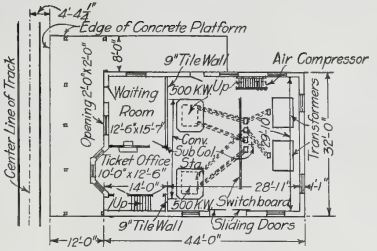


Second Floor Plan

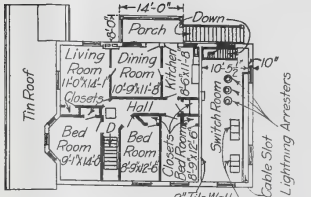
Front Elevation



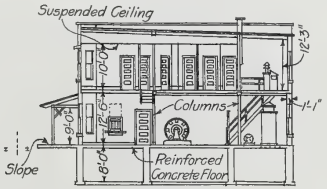
Foundation Plan



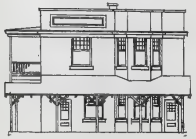
First Floor Plan



Second Floor Plan



Longitudinal Section



Front Elevation

FIG. 12. DESIGN FOR SUB-STATION OF ABOUT 1000 KW. CAPACITY.

In Appendix **A** will be found the Standards of the Central Traction and Lighting Bureau (New York City) and which apply to the United States and greater portion of Canada.

Respectfully submitted,

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H. G. THROOP,
TERANCE SCULLIN,
L. C. DATZ,
F. H. MILLER,
C. F. BEDWELL, *Chairman,*

Committee on Buildings and Structures.

APPENDIX A

STANDARDS OF THE CENTRAL TRACTION AND LIGHTING BUREAU AS REGARDS ELECTRIC LIGHT, POWER, TRANSFORMER AND (OR) STORAGE BATTERY STATIONS

WALLS:

1. Hard burned brick, stone or reinforced concrete (see National Board Standard). If brick or reinforced concrete, to be not less than twelve (12) inches in thickness for buildings not over fifteen (15) feet in height, and to increase four (4) inches for each additional fifteen (15) feet or greater portion thereof. If pilaster or pier construction, such pilaster or piers shall be not less than sixteen (16) inches in thickness, increasing four (4) inches for additional height as above noted, and should have a face of not less than one-fifth of the distance between pilaster centers. Curtain walls to be not less than twelve (12) inches in thickness. If stone, to be increased four (4) inches over dimensions prescribed.

CUT-OFF WALLS:

2. Brick, stone or reinforced concrete and of thickness specified for outside walls, except that non-bearing walls need not exceed twelve (12) inches in thickness for height of thirty (30) feet or less.

PARTITIONS:

3. Must be of non-combustible material.

PARAPETS:

4. On all exposed or cut-off walls, unless roof is of non-combustible material, parapets must be at least twelve (12) inches thick, provided with durable and non-combustible coping, and rise not less than two (2) feet above roof.

ROOF:

5. Must be constructed of non-combustible material and have non-combustible covering or approved composition.

ROOF TRUSSES:

6. All metal to be insulated on the sides by not less than four (4) inches, and on the top and bottom by not less than two (2) inches of concrete, terra-cotta or other approved insulating material recommended in the Building Code of the National Board of Fire Underwriters.

SKYLIGHTS:

7. Must be of approved wired glass in standard metal frames.

FLOORS:

8. Concrete, cement, iron, brick, stone or earth.

STAIRS:

9. Must be of non-combustible material.

FINISH:

10. Finish (interior trim) to be non-combustible.

EXTERIOR ATTACHMENTS:

11. Building shall be free from combustible cornice, porches or other exterior attachments.

HEIGHT:

12. One story without basement or storage space below except for condenser pits and foundations.

LIGHTING:

13. By electricity or gas: Wires to be installed in approved conduits and in accordance with rules of the National Electrical Code. All gas brackets or burners to be stationary and well away from combustible material.

HEATING:

14. Steam, hot water or hot air, pipes to be free from wood work and supported by iron hangers.

FUEL OIL SYSTEMS:

15. Must be constructed and installed to conform to the specifications of the National Board of Fire Underwriters.

OCCUPANCY:

16. Light and (or) power station only.

GENERATORS:

17. When operating at a voltage in excess of 550, frames shall be permanently and effectively grounded. At lower voltages frames shall be either thoroughly insulated or effectively grounded.

CONDUCTORS:

18. From generators to switchboards, rheostat or other instruments and thence to outside lines:

(*a*) Must be in plain sight or readily accessible, or if properly insulated, lead encased cable may be laid in approved non-combustible conduits.

(*b*) Where a number of wires are brought close together, as is generally the case in dynamo rooms, especially on or about switchboards, they must be surrounded with a tight, non-combustible outer cover (not to apply to low tension bus bars).

(*c*) Wires shall be carried as direct as possible from the switchboard to the point at which they leave the building, and if leading to aerial lines shall incline downward to prevent the entrance of rain along the wires.

(*d*) Must be separated from contact with floors, partitions or walls through which they pass, by non-combustible, non-absorptive insulating tubes, such as glass or porcelain, with distance between sufficient to prevent possible contact. Must have no air space where they pass through floors from basement to switchboard other than that of the insulating tubes.

(*e*) Other than for exciters all constant potential generator leads, with the exception of the neutral of a three-wire system and the grounded side of a railway system, must be protected by approved automatic cut-outs at the station.

(*f*) In all other respects wires shall be installed to conform to the rules of the National Electrical Code.

LIGHTING AND POWER WIRES:

19. To be installed in approved conduits to conform to rules of the National Electrical Code.

SWITCHBOARDS:

20. (*a*) Must be of non-combustible material such as marble or slate.

(*b*) Must be accessible from all sides. Boards must be kept free from moisture.

(*c*) Switching apparatus for currents in excess of 6,600 volts shall be operated through remote control switches.

(*d*) All oil switches, whether automatic or non-automatic, controlling current at a difference of potential in excess of 6,600 volts shall be enclosed in fire-proof compartments.

RESISTANCES:

21. (*a*) Must be of approved type and not located in proximity to combustible material.

(*b*) Insulated wire for connection between a rheostat and its contact plate shall have approved flame-proof insulation.

IN GENERAL:

22. All apparatus and wiring must be maintained in good condition and unless otherwise specified must conform to the rules of the National Electrical Code.

LIGHTNING ARRESTERS:

23. (*a*) Must be connected to each wire of every overhead circuit connected with the station.

(*b*) Must be of approved type and located in readily accessible places away from combustible material and as near as practicable to the

point where the wires leave the building. If the voltage of the circuit is in excess of 6,600 a special fire-proof room, compartment or building shall be provided to contain such arresters.

(*c*) In all cases, kinks, coils and sharp bends in the wires between the arresters and the outdoor lines must be avoided if possible.

(*d*) Must have an effective and permanent ground connection by metallic strips or wires having a conductivity not less than that of a No. 4 B. & S. gauge copper wire, which must be run as nearly as possible in a straight line from the arresters to the ground connection.

(*e*) All choke coils or other attachments, inherent to the lighting protective equipment, shall have an insulation from the ground or other conductors equal at least to the insulation demanded at other points of the circuit in the station.

TRANSFORMERS:

24. (*a*) Oil transformers used for stepping the current up or down before distribution, shall be located in a fire-proof room or compartment provided for the purpose, cut-off by standard fire door and such compartment shall be equipped for drainage in case of oil escaping from a transformer case The door sill shall be raised at least six inches above the floor to insure the non-escape of oil into the building.

(*b*) Air cooled transformers should be isolated as far as possible from other apparatus and supplied with air through fire-proof duct.

GAS ENGINES:

25. Construction and installation must conform to the rules of the National Board of Fire Underwriters.

WASTE CANS:

26. Standard metal waste cans must be provided, and all oily waste kept therein.

LOCKERS:

27. Approved metal lockers must be provided.

OILS:

28. Not exceeding three barrels of lubricating oils may be kept in standard cabinets, or central oiling system may be used; otherwise all, except only one day's supply, must be kept in separate building or in fire-proof room in building, properly drained and ventilated and cut off by standard fire door.

WATCHMAN:

29. If not running night and day continuously, there must be an approved watchclock and hourly record made thereon, all dials to be kept on file for inspection. Will not be required in stations having ground area of less than 2,500 square feet.

Internal Fire Protection

SAND AND WATER PAILS AND EXTINGUISHERS:

30. (*a*) In stations of non-combustible construction (see note under deficiency charge No. 29) there shall be provided, for each 2,000 square feet of floor area, three (3) pails of sand and one (1) extinguisher of the one (1) quart or more capacity type, approved by the National Board of Fire Underwriters, for use where water or solutions containing large percentages of water are not effective. Not less than three (3) pails of sand and one (1) approved extinguisher in any station.

(*b*) In stations of other than non-combustible construction, three (3) sand and water pails for each 2,000 square feet of floor area, but not less than six (6) in any station. One-half the number of pails to be kept filled with dry sand and one-half with clean water. One (1) approved chemical fire extinguisher (extinguishers described in preceding paragraph will be acceptable) may take the place of three (3) pails of water.

INSIDE HYDRANTS OR VERTICAL PIPES:

31. Must be fed by pipe not less than three inches in diameter; sufficient number of connections must be so located that, with not exceeding seventy-five (75) feet of hose connected to each, any part of the building can be reached by hose. In standard stations, inside hydrants or vertical pipes will only be required where necessary to protect combustible contents other than electrical equipment.

HOSE FOR INSIDE CONNECTIONS:

32. Must be of linen of approved make, not less than 1½ inch diameter, with not exceeding ¾ inch nozzle (spray nozzles preferred). Not exceeding seventy-five (75) feet of hose shall be kept (hung or racked) attached to each connection.

WATER SUPPLY:

33. Inside connections shall have adequate supply of water at pressure sufficient to throw streams above highest point of buildings; supply to be from city service, or approved fire-pump of not less than 500 gallons capacity per minute and available for immediate use at all times; or from tank having capacity of not less than 10,000 gallons, down pipe, where exposed, to be protected from freezing.

External Fire Protection

(See note under deficiency charges 31 to 38.)

WATER SUPPLY:

34. There must be not less than two double, standard hydrants, connected with not less than a 6-inch main within 300 feet of the building. Source of supply to be sufficient to furnish a 250-gallon stream from each opening at sufficient pressure to throw water over the highest

point of the building and to supply such streams from all openings at one time continuously for a period of at least one hundred (100) minutes.

FIRE DEPARTMENT:

35. Not less than four (4) full paid men constantly on duty (8 men if with hook and ladder truck), one hose cart or reel with two hand chemical extinguishers and one hook and ladder truck, all drawn by department horses, 1,000 feet of standard 2½-inch hose and 1-inch nozzles, wrenches, etc., where total ground floor area of all buildings of plant does not exceed 20,000 square feet, and 2,000 feet of hose where area exceeds 20,000 square feet. Men and quipment (except hook and ladder truck and 4 men for same) to be located in fire department house within one-half mile of plant over unpaved streets, or within one mile over paved streets.

Where all equipment (except hook and ladder truck) is drawn by automobiles, all distances specified for location of fire department house may be doubled.

FIRE ALARM:

36. Telegraph fire alarm station to be within 300 feet of building. Unless keyless box, there must be a key at the building.

Base Rates

WHERE CONSTRUCTION WARRANTS USE OF BASE RATE NO. 1 OR 2, CHARGES FOR DEFICIENCIES AS PER COLUMN NO. 1 APPLY, UNLESS SPECIFICALLY EXCEPTED. CHARGES IN COLUMN NO. 2 ARE APPLICABLE WHEN BASE RATE NO. 3 IS EMPLOYED

	Standard	.07
1. **Walls.**— Brick, stone or reinforced concrete, deficient in thickness, each outside wall	.01	
	Standard	.07
2. **Walls.**— Cement block, tile, terra-cotta, corrugated iron on steel frame, or other non-combustible material not specifically mentioned in standard, each outside wall	.08	
	Standard	.07
3. **Walls.**— Brick-veneer, frame, corrugated iron on wood sheathing, corrugated iron on skeleton wood frame or other combustible material, each outside wall	.15	
	Basis Rate	

CHARGES FOR DEFICIENCIES

	Column one	Column two
1. Partitions.		
(*a*) Not as in requirements	.02	
2. Parapets.		
(*a*) Deficient in thickness	.01	
(*b*) Deficient in height	.01	
NOTE.—*Not to apply unless roof is charged for combustible material.*		
3. Roof.		
(*a*) Wood sheathing on steel trusses	.03	
(*b*) Wood sheathing on wood trusses, mill construction	.07	
(*c*) Wood sheathing on wood trusses or joisted construction	.10	
(*d*) Unapproved composition	.15	.15
(*e*) Shingle	.25	.25
NOTE.—*When charge is made under (d) or (c), make none under (a), (b) or (c).*		
4. Unprotected Metal.		
(*a*) Beams and (or) girders not properly protected	.01	
(*b*) Columns not properly protected	.01	
5. Skylights.		
(*a*) If not standard, for first skylight	.02	
(*b*) For each additional	.01	
NOTE (1).—*Maximum charge under (a) and (b) not to exceed .07.*		
NOTE (2).—*Non-standard skylights of abnormally large area must take maximum charge.*		
6. Floors.		
(*a*) Wood laid upon ground, cement or concrete, no space beneath	.02	.04
(*b*) Wood laid upon ground, cement or concrete, space beneath	.03	.05
(*c*) Heavy, slow burning	.04	.08
(*d*) Wood, ordinary joisted	.10	.15
7. Stairs and Openings.		
(*a*) Other than to foundations or condensers, if open	.05	.10
(*b*) If in tower and not cut off properly	.02	
NOTE.—*Not to apply to Base Rate 1 unless floors are charged for combustible material.*		

	Column one	Column two
8. Finish — Combustible.		
(*a*) Finish leaving concealed spaces in walls.....	.03	.05
(*b*) Finish leaving concealed spaces in ceiling.....	.03	.05
NOTE.—*Not applicable to offices or club rooms of small area.*		
9. Exterior Attachments.		
(*a*) Cornice or similar attachments of combustible material, if on exposed station.....	.02	
(*b*) Wood porches, awnings, bridges, monitors....	.02	
(*c*) If main building is of construction designated in standard or under Base Rates 1 or 2, and additions thereto are constructed of material specified under Base Rate 3, for each 100 square feet area of additions up to 50% of area of main building.....	.01	
NOTE:—*In excess of 50% of main building, employ Base Rate 3.*		
10. Area.		
(*a*) For each 1,000 square feet or greater fraction thereof ground area in excess of 7,500.....	.01	.01
NOTE.—*Not to apply to Base Rate 1 unless roof or floors are charged for combustible material.*		
11. Height.		
(*a*) Each story in excess of one, floors non-combustible	.01	.03
(*b*) Each story in excess of one, floors combustible.	.02	.05
NOTE.—*Basement or space below to be counted a story.*		
12. Lighting, other than by electricity.		
(*a*) Kerosene in metal lamps safely arranged.....	.05	.10
(*b*) Kerosene in metal lamps not safely arranged, not less than.....	.10	.25
(*c*) Gasoline lighting systems with gasoline fed to carbureter or generator by gravity or compressed air from supply tank or reservoir outsite of building.....	.15	.15
(*d*) Gasoline lighting systems with gasoline fed to cabureter or generator by gravity or compressed air from supply tank or reservoir inside of building.....	.25	.25
(*e*) Swing gas brackets.....	.10	.10

	Column one	Column two
13. Lighting, by electricity.		
(*a*) Standard, except wires not in conduits	.01	.02
(*b*) Lighting equipments, installation defective, not less than	.05	.10
NOTE.— (*a*) *and* (*b*) *charges are cumulative.*		
14. Heating.		
(*a*) Other than standard requirements, not less than	.03	.05
NOTE.— *Stoves safely arranged may be permitted in offices without charge.*		
(*b*) Boiler or furnace inside, safely arranged, but not in fire-proof room	.03	.05
NOTE.— *Charges under a or b not to apply to Base Rate 1 or 2 unless floors are charged for combustible material.*		
(*c*) Boiler or furnace otherwise not conforming to requirements, to include stack deficiencies not to exceed	.10	.15
15. Fuel Oil.		
(*a*) Gravity feed, or otherwise not conforming to National Board Rules	.10	.25
16. Occupancy.		
(*a*) For freight, express and (or) waiting room	.05	.05
(*b*) Other occupancy except central heating plant, charge according to hazard		
17. Conductors.		
(*a*) Wires concealed and not as required	.05	.10
(*b*) Wires not provided with proper protective devices	.05	.10
(*c*) Wires improperly insulated or supported	.05	.10
NOTE.— *When Base Rate 1 is used and no charge is made for combustible material in floor or roof, one-half of charges to apply.*		
18. Switchboard.		
(*a*) Solid wood	.25	.25
(*b*) Skeleton wood	.10	.10
(*c*) Not properly located	.01	.05
(*d*) Not conforming to standard requirement *c*	.01	.05
(*e*) Not conforming to standard requirement *d*	.01	.05
NOTE.— *If no charge is made for combustible material in floor or roof, reduce charges under* (*a*) *and* (*b*) *one-half.*		
19. Resistances.		
(*a*) Not standard, or if improperly mounted	.05	.15

	Column one	Column two
20. Lightning Arresters.		
(*a*) All circuits not equipped	.02	.10
(*b*) Improperly located	.01	.10
(*c*) Otherwise not standard	.02	.05
21. Transformers.		
(*a*) Not arranged as in requirements, not less than	.03	.10
22. Boiler.		
(a), (b), (c), (d) and (f) not to apply to Base Rate 1 or 2 unless roof or floors are charged for combustible material. When Base Rate 1 or 2 is employed and combustible material in roof only is charged for, make one-half charge under (a) and (c).		
(*a*) In main building	.15	.45
(*b*) In brick building adjoining or within 10 feet, wall parapeted, openings protected	.00	.00
(*c*) In brick building adjoining or within 10 feet, wall not parapeted and (or) openings unprotected	.10	.15
(*d*) In frame building adjoining or within 10 feet, wall parapeted, openings protected	.10	
(*e*) In frame building adjoining or within 10 feet, walls not parapeted and (or) openings unprotected	.15	.35
(*f*) Highest point of boiler less than 6 feet from combustible roof	.05	.15
23. Stack.		
(*a*) Metal stack through combustible roof properly ventilated	.02	.05
(*b*) Improperly ventilated, not less than	.10	.10
24. Gas Engines.		
(*a*) Not installed to conform to National Board Rules	.03	.10
25. Waste Cans.		
(*a*) None or not standard	.03	.05
26. Lockers.		
(*a*) Not according to standard	.02	.05
27. Oils.		
(*a*) Lubricating or kerosene oil, paints, varnishes or turpentine, not conforming to standard requirements	.10	.20
(*b*) Benzine or gasoline, if stored in building, unless in fire-proof room cut off by standard fire door	.15	.30

	Column one	Column two
28. Watchman.		
(*a*) Not according to standard	.02	.10
29. Pails of Sand and Water or Extinguishers.		
(*a*) If not as required	.05	.10
NOTE.—*If Base Rate 1 or 2 is employed and no charge is made for combustible material in roof or floors, charge shall be made unless sand pails and extinguishers are provided as required in standard.*		
30. Vertical Pipes and Hose.		
(*a*) None, or not standard	.05	.05
NOTE.—*Not to apply to Base Rate 1 unless floors are charged for combustible material. If roof only is charged for combustible material, reduce charge one-half.*		
External Protection.		
31. Water supply and (or) mains deficient, not less than	.02	.02
32. (*a*) Only one hydrant within 300 feet of station	.02	.02
(*b*) One or more hydrants between 300 feet and 500 feet of station	.03	.03
(*c*) Hydrants beyond maximum distance specified in *b*	.05	.05
NOTE.—(1).—*Charges under (a), (b) and (c) are not cumulative.*		
NOTE (2).—*If distance to nearest hydrant is in excess of 750 feet, rate risk as unprotected.*		
33. Hydrants non-standard	.01	.01
34. Location of fire department, not as required	.02	.02
NOTE.—*If distance to nearest fire department house exceeds 1½ miles, with horse-drawn apparatus, or 3 miles with motor-driven apparatus, make full charge under 37.*		
35. (*a*) Department partially paid, but less than requirement	.02	.02
(*b*) All volunteer	.03	.03
NOTE.—*Charges under (a) and (b) are not cumulative.*		
36. Equipment of department deficient, but not less than 500 feet of standard 2½-inch hose	.03	.03
NOTE.—*Charges under Nos. 31, 32, 33, 34, 35 and 36 are cumulative.*		
37. No fire department	.10	.10

	Column one	Column two
38. No external water protection	.10	.10

NOTE (1).— *Charges 31 to 38 inclusive not to apply to unexposed stations when Base Rate 1 is employed, unless floors are charged for combustible material. If roof only is charged for combustible material, reduce charges one-half.*

NOTE (2).—*Charges under 37 and 38 are cumulative.*

39. Fire Alarm.

(*a*) Not standard	.02	.02

NOTE.— *Not to apply unless paid or partially paid fire department is accessible, nor to apply to Base Rate 1, unless roof or floors are charged for combustible material.*

40. Care and Maintenance.

(*a*) Charge according to conditions.....

41. Age and Condition.

(*a*) Charge according to conditions.....

42. Exposures.

Charge as per table.....

RATES.— *Building and contents other than electrical*

Deduction.

43. For watchman reporting to central station under approved system of supervision	5%	5%

NET RATES.— *Building and contents other than electrical with 80% reduced rate average clause*

44. For rate on electrical contents add as follows to net building rate:

(*a*) If no charge is made for combustible material in roof or floor	.05	.05
(*b*) If charge is made for combustible material in roof only	.12	.12
(*c*) If charge is made for combustible material in floor or floor and roof	.15	.15

NET RATES.— *Electrical contents with 80% reduced rate average clause*.....

NOTE.— *Where rates without reduced rate average clause are required, add 50 cents to building and all contents.*

45. Taxation.

For excessive state or municipal taxation.

RATES FOR PROMULGATION

Without R. R. A. C.:
Building and contents, except electrical contents...
Electrical contents .....
With 80% R. R. A. C.:
Building and contents, except electrical contents..
Electrical contents .....

RULES

Forms covering building and contents under single item shall carry 90% reduced rate average clause and be governed by the highest rated subject, unless average rate has been specifically promulgated.

Average rates will be made and promulgated, based upon values furnished under signature of assured.

EXPOSURES

(*a*) Figure exposure charges to and from all buildings according to exposure table.

Exposure charge should be figured according to construction of facing walls.

(*b*) In the subjoined table figures in heavy faced type are decimal ratios of the exposed estimate of exposing risk (less exposure charges, if any, from risk to which exposure is to be figured); to be charged when risk stands within 10 feet of exposure. The fractional figures beneath each decimal indicate reduction allowance for each 10 feet of clear space between exposing and exposed risks.

(*c*) Exposures are classed as small, ordinary or large and are graded as such by Dimension Table according to area and height of risk from which exposure is to be figured. Exposures from "negligible" buildings may be waived.

(*d*) Exposure charges to non-combustible buildings with non-combustible contents should be reduced one-half. Exposures from such buildings with non-combustible contents may be waived.

(*e*) The exposure charge from one building to another building of same ownership may be reduced one-fifth and should in no case exceed 80% of the increase in estimate that would result if the two buildings were joined together and rated as one building.

(*f*) Exposure charges to or from all buildings with parapeted brick, stone or concrete fire walls without openings, or with openings, protected by standard fire doors and shutters should be waived; except if exposed within 20 feet by buildings with frame, iron-sheathed frame, brick-veneer or skeleton iron-clad walls, one-half regular exposure charge should be made.

(*g*) If charge is made under Nos. 37 and 38, brick-veneered, frame, corrugated iron on wood sheathing, or corrugated iron on skeleton wood frame buildings detached less than ten (10) feet, shall all be given the highest estimate, including all exposure charges.

EXPOSURE TABLE

Exposed wall	Exposing walls								
	Frame, iron-sheathed frame			Skeleton iron-clad Brick-veneered			Brick, stone Concrete		
	Small	Ordinary	Large	Small	Ordinary	Large	Small	Ordinary	Large
Frame	.40 1/5	.40 1/6	.40 1/10	.24 1/3	.28 1/4	.36 1/6	.08 All	.12 1/2	.20 1/4
Iron-sheathed, frame skeleton, iron-clad brick-veneered	.24 1/3	.28 1/4	.36 1/6	.16 1/2	.20 1/3	.28 1/5	.06 All	.10 1/2	.18 1/4
Brick, stone, concrete	.12 1/3	.16 1/4	.24 1/6	.08 All	.12 1/2	.20 1/4	.04 All	.08 1/2	.16 1/4

DIMENSION TABLE

The following Dimension Table specifies the area for various heights at which an exposing risk grades as "large," "small," or "negligible." When area is less than specified for "large" and more than specified for "small," exposing risk should grade as "ordinary."

Wall construction		Height in stories	Ground floor area
Frame Iron-sheathed Frame, skeleton Iron-clad Brick-veneered	Large	1	8,000,
	Large	2	5,000
	Large	3 and over	All buildings
	Small	1	1,000
	Small	2	400
	Negligible	1	400
Brick Stone Concrete Skeleton-steel Hollow-cement-block, tile	Large	1	12,000
	Large	2	8,000
	Large	3	5,000
	Large	4 and over	All buildings
	Small	1	1,000
	Small	2	500
	Negligible	1	500

REPORT OF COMMITTEE ON STANDARDS CONCERNING RECOMMENDATION OF THE COMMITTEE ON BUILDINGS AND STRUCTURES

1914-1915

Recommendation of Committee on Buildings and Structures:

(*a*) AS RECOMMENDED SPECIFICATION: General Specification and Form of Contract for Railway Structures, as shown on page 307.

Action of Committee on Standards:

Disapproved, inasmuch as it is thought that this Specification and Form of Contract are not suitable for adoption as a Standard or Recommendation.

Recommendation of Committee on Buildings and Structures:

(*b*) As Recommendation. Rules for Instruction to Employes for Fire Protection as shown on page 327. That they be approved as a Recommendation.

Action of Committee on Standards:

Adoption as **Recommended Rules** approved.

Respectfully submitted,

C. F. Bedwell,
W. G. Gove,
E. R. Hill,
A. S. Richey,
J. W. Welsh,
C. S. Kimball,
E. B. Katte,
W. H. Sawyer,
F. R. Phillips,
J. H. Hanna,
C. H. Clark,
Martin Schreiber, *Vice-Chairman,*
H. H. Adams, *Chairman,*
Committee on Standards.

Acting Secertary Stocks:— With reference to the Fire Protection Rules, I might say that they have been under consideration for the past two or three years. The 1913 Committee in its report gave in full the rules on this subject and recommended their adoption. The Committee on Standards at that time felt that it could not give its approval to the rules until they received the official approval of the National Fire Protection Association. This was received at the last meeting of the National Fire Protection Association and these rules are to be incorporated as a part of their Fire Code.

Discussion of Report of Committee on Buildings and Structures

President Crecelius:— The only recommendation in the report is that the Rules for Instructions to Employes for Fire Protection, as mentioned on page 327, be approved as a Recommendation.

John Lindall:— The Committee on Standards has approved the adoption of these Rules as a Recommendation.

C. R. HARTE:— I move that the recommendation of the Committee on Standards be approved.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:—The next subject for consideration is the General Specifications and Form of Contract for Railway Structures.

JOHN LINDALL:— The Committee on Standards disapproved the adoption of the General Specification and Form of Contract for Railway Structures as a Recommendation, inasmuch as it was thought that this specification and form of contract was not suitable for adoption as a Standard or Recommendation.

C. R. HARTE:— It seems to me desirable that the incoming Committee on Buildings and Structures be instructed to confer with the Committee on Standards to develop the points that led to the disapproval of the general specification, and then see if something cannot be done towards formulating at least a foundation for uniform specification. Of course, there are apt to be local conditions requiring special treatment although "local condition" is very often a worse bugbear in the distance than when close to, but it does seem desirable to have some foundation of uniformity for our general construction. I am not sure whether or not the American Institute of Architects have a uniform specification, but I believe they had at least an outline, with more or less detail, in which there are many factors standardized, and it seems to me that we ought to be able to put forth something next year which would be a groundwork for a reasonable standard for our buildings and structures.

I am not quite sure that it is in order to move that such action be taken, or whether the fact that the matter has come up in the discussion will automatically bring it to the attention of whatever committee has the matter in charge, but I feel strongly that the subject should be continued and particularly that the cause of the successive disapprovals each year be brought out and eliminated.

PRESIDENT CRECELIUS:— The point raised by Mr. Harte is pertinent. This Committee has worked for years in the attempt to produce a specification which might be used as a

Recommended Specification for buildings and structures, and each year, for several years, their recommendations have failed for lack of approval. The reason, no doubt, is thoroughly understood, but, nevertheless, from the results so far obtained, I believe that in order to support the Committee the question should be again rejuvenated, and a motion that the recommendation for a standard specification be continued is in order and I believe is required. Otherwise the matter may be lost sight of.

C. R. HARTE:— I move that such action be taken.

(Motion duly seconded, stated and carried.)

E. J. BLAIR:— I do not like to see these things passed over too lightly, and although I am not a building and structure man, I am very much interested in the design of sub-stations on page 336.

I thought it might be an opportune time to call attention of those present to that matter of the U. S. Bureau of Standards' recommendations. I presume probably most every one here has been in direct conference with the Bureau of Standards. If you have not, you have missed something. The representatives came to Chicago and spent a couple of days with us, and I understood they were going as far as the Coast. I believe in the final consultation; our Engineering Association will be represented. I bring that out and call your attention to it, so that if you have any ideas on these recommendations you can send them in to Prof. A. S. Richey, who represents us, I think, in the Conference, and who will make an earnest effort to get something that is workable and something that meets with the approval of the railroad and the electric light men throughout the country. I am sure from the talk I have had with Professor Richey that he will appreciate any help you care to send in the way of written comment on the rules. A meeting of the Bureau on this subject is to be held very shortly.

ACTING SECRETARY STOCKS:— Since Mr. Blair brought up the subject of the U. S. Bureau of Standards Rules, I might outline what the Association has done on this subject. He mentioned the fact that we have representatives appointed to

confer with the U. S. Bureau of Standards on this subject. Those representatives consist of Mr. W. J. Harvie, as representing the American Association, and Mr. C. L. Cadle and Prof. A. S. Richey, representing this Association. On September 29 and 30, 1915, they held a two days' session in Rochester, N. Y., with representatives of the various sectional associations in the East, which include the Pennsylvania Street Railway Association, the New York Electric Railway Association, and the Central Electric Railway Association. They did not complete the work in that two days' session so as to cover all the written criticisms on these rules, which are commonly known as Bulletins 49 and 54 of the U. S. Bureau of Standards. Another meeting will shortly be held, in New York, to further consider these same subjects, and at that meeting, I understand representatives of the U. S. Bureau of Standards will be in attendance.

The final meeting when the U. S. Bureau of Standards hopes to have the notes in some mutually agreed form is to be held the latter part of this year in Washington, so that there is yet considerable time for anybody who wants to make any further discussion or criticisms of these rules to forward them to Mr. E. B. Burritt, the secretary of the Association, and he will place them in the hands of the Committee.

PRESIDENT CRECELIUS:— With reference to the National Electrical Safety Code in preparation by the U. S. Bureau of Standards, I advise all the representatives of the railways to take a deep interest in this bulletin. It is a very important matter, and is something which will govern not only your construction, but your operations with regard to that construction, and it will, therefore, vitally affect the industry as a whole. Therefore, while the Association has made every effort to give the conferences and the work of our representatives there, every bit of publicity possible, at the same time every opportunity to drive home the fact that the Bulletin is in process of preparation should be taken advantage of, and I urge that, as the individual duty of every member, he examine the bulletin and discuss the subject with his associates, so that the very largest expression of opinion can be had by our representatives for the final meeting.

H. J. KENNEDY:— The question has been brought up of the safety of the sub-station design. I think an important factor of sub-station safety is the amount of space around the apparatus which you may take up with your cables in conduit, and so on, and the placing of switches on the upper gallery. It seems to me that the spacing in the design shown is cut down to the minimum. Where you undertake to enclose a complete sub-station, and a living-room, kitchen, and a railway waiting-office and waiting-room, in a building 32 by 44, it seems to me it is getting it down to a very small magnitude.

I also notice that the design calls for rotary converters. Now, there are some cases in which motor generators are used, and in that case the building is too small, as there is not sufficient space for motor generators. Furthermore, even if rotary converters are used the space for making repairs is so small that if a rotary converter is taken apart you are endangering the safety of the instruments on the switch-board, for there is not enough room for the men to walk around when all the parts are laid out on the floor.

I think this is a praiseworthy plan to reduce capital expenditure, yet I would recommend that the question of the complete size of that sub-station be taken into consideration before adopting it as a standard.

C. R. HARTE:— I think there are two elements to be considered. If there is scant space around the machines the operators are in danger and particularly with a low ceiling, if there is not artificial ventilation, there is likely much trouble from heating, particularly in Summer, which reduces the efficiency both of machines and of men.

ACTING SECRETARY STOCKS:— With regard to the design shown in Fig. 12, the Committee distinctly says it is for a sub-station, without extra space for a third machine. However in the recommendations for design the fact is mentioned that space should be left for a third machine. The design as shown in Fig. 12 is, I believe, an actual station, with the living quarters in the second story, and the switching gallery in the rear. It will be noted, also, that the living quarters extend well to the front, so that the waiting-plaforms are underneath the second story.

PRESIDENT CRECELIUS:— If there is no further discussion we will conclude the program for today, although before adjournment I would like to give the Committee an expression of appreciation of the Convention for its report.

E. J. BLAIR:— I move you that this report be received, and that proper appreciation be expressed to the Committee for their carefully prepared report.

(Motion duly seconded, stated and carried.)

There being no further business the meeting adjourned.

WEDNESDAY SESSION

October 6, 1915

Joint Meeting of the Accountants' and Engineering Associations, Yosemite Hall

The meeting was called to order at 2:15 P. M. with President Mitchell, of the Accountants' Association, and President Crecelius, of the Engineering Association, on the platform; President Mitchell presiding.

President Mitchell:— This joint meeting of the Engineering Association and the Accountants' Association has been called to receive and consider the reports of the Joint Committee on Engineering-Accounting and the Joint Committee on Life of Railway Physical Property. I will ask Mr. Harte, one of the Co-Chairmen, to present the report of the Committee on Engineering-Accounting.

C. R. Harte presented the report, and during its presentation said: It seemed to your Committee that it would be very hard to secure standardization of the cost accounting forms in the sense of having them all exactly alike, but that it was highly desirable that all should show those elements which were set forth in the report of last year's Committee. Instead therefore of a standard set of forms there are shown two sets, each of which has proved satisfactory in service, to suggest ways of embodying necessary additions to forms now in use.

REPORT OF JOINT COMMITTEE ON ENGINEERING-ACCOUNTING

To the American Electric Railway Engineering and the American Electric Railway Accountants' Associations:

Gentlemen.—At a meeting of the Executive Committee of the Engineering Association held in New York on November 10, 1914, the following subjects were assigned for investigation by the Joint Committee on Engineering-Accounting:

(a) Cost Accounting: Draft a set of standard forms for use with the system recommended by the 1914 Committee.

(b) Revision of sub-division of Operating Maintenance Accounts to meet the new Interstate Commerce Commission classification.
(c) Development of a proper ledger looking towards the maintenance of a continuous inventory.

The above mentioned subjects were duly agreed to by the Accountant's Association, which had no further subjects to assign for consideration by this Committee. The Joint Committee first met in New York, and after a general discussion of the subjects indicated, it was thought best to appoint sub-committees for more detailed study and the preparation of reports. The organization of the sub-committees was as follows:

To draft a set of standard forms for use with the system recommended by the 1914 Committee: Messrs. Barnes, Collins, Lahr and Clark.

To revise the sub-division of Operating Maintenance Accounts to meet the new Interstate Commerce Commission classification: Messrs. Harte, Ripley, Sillick and Gidney.

To develop a proper ledger for the maintenance of a continuous inventory: Messrs. Clark, Sillick, Glover, and Schreiber.

As a result of the labors of said sub-committees, the following report is submitted for your consideration.

COST ACCOUNTING FORMS FOR USE WITH THE SYSTEM RECOMMENDED BY THE 1914 COMMITTEE

The system recommended by the 1914 Committee contemplates a set of co-related forms on which to record the following particulars for each job or undertaking:

(1) Preliminary estimate of the cost of the work to be done.
(2) The actual or estimated original cost of the work to be replaced (if any).
(3) An authorization by the proper official for the expenditure of the amount of the estimate.
(4) A notice of completion from the engineering department to the accounting department.
(5) A statement of the actual cost compiled by the accounting department, comparable with the preliminary estimate.
(6) Supplemental authorization covering over expenditures (if any).
(7) Certificate of completion to be furnished by the accounting department to the authorizing officers, cancelling any unexpended balances.

The duty laid upon your Committee to draft a set of forms for use with the system recommended by the 1914 Committee, and as indicated in the foregoing, has been found to be a perplexing one for the reason

that each member company has its own peculiarities of organization and other local conditions which in many cases may seem to necessitate widely differing methods of compiling and forwarding reports.

Your Committee has therefore departed somewhat from the letter of its instructions, and instead of embodying in this report a set of blanks to be considered as standard, we have taken the liberty of submitting herewith two sets of blanks which have been selected as in most particulars covering all the requirements of the system, leaving it to the member companies to select, each for itself, such features as may seem best to suit its own individual requirements or to cull out from these blanks such features as may serve to amplify the system which it already has in operation.

The blanks which follow, therefore, as a part of this report, are offered more in the nature of suggestions, and subject to such adaptations as may suggest themselves to the member companies, having in mind rather the standardization of the idea than of the detail.

Form A–1 (Size 8½ x 11) **ORIGINAL**

AMERICAN ELECTRIC RAILWAY COMPANY

DETAILS OF ESTIMATED COST OF MATERIAL AND LABOR COVERED BY APPLICATION NO. .....

(NOTE.— This form should be prepared in quadruplicate and should give details of the amounts shown in total on the front sheet of Form A-3 which form it should accompany.)

Office of.....

Date.....

Address.....

	Material to be Purchased		Material on Hand in Stores or Elsewhere		Labor	
Total.....						
Total Labor.....						
Material to be purchased						
Material on hand.....						
GRAND TOTAL....						

Signed .....

(Form A-1

Form A–2 (Size 8½ x 11) **ORIGINAL**

AMERICAN ELECTRIC RAILWAY COMPANY

DETAILS OF ESTIMATED SALVAGE MATERIAL (including scrap) TO BE ABANDONED, REMOVED OR REPLACED AND RETURNED TO STORES OR TO BE USED ON THIS WORK

Covered by Application No.....

(NOTE:— This form should be prepared in quadruplicate and should give details of the amount shown in total against the words " Less Credit " on the front sheet of Form A-3 which form it should accompany.)

Office of.....

Date.....

Address.....

	To be used on this work		To be returned to Stores	
TOTAL				
Add to be used				
GRAND TOTAL				

Signed.....

(Form A-2)

Form A–3 (Size 8½ x 22) **ORIGINAL**

AMERICAN ELECTRIC RAILWAY COMPANY

Application for authority to proceed with and for appropriation to cover the cost of

ADDITIONS, BETTERMENTS, REPLACEMENTS and EXTRAORDINARY REPAIRS

Office of..... Application No.....

Address..... Date.....

AUTHORITY is requested for an expenditure of $.....

for.....estimated, as follows:
(Here state whether addition, etc.)

To.....

.....

Material to be Purchased (Form A-1).....		
Material on Hand (Form A-1).....		
Labor (Form A-1).....		
Other Expenditures.....		
Less Credit (Form A-2).....		
TOTAL.....		

Necessity for Proposed Expenditure: (Underline the reasons which apply)

1. To insure greater safety.
2. To promote or increase earnings.
3. To reduce cost of maintenance or operation.
4. To improve existing conditions.

Recommended by..... (Title).....

Accepted by.....

Approved by.....

Approved by.....

Charges and Credits under this authority apply against A. F. E. No.....

.....*Comptroller*

This expenditure is authorized.

Date..... .....*Vice-President*

Obverse Side Form A-3 (OVER)

Form A–3

INSTRUCTIONS

1. **APPLICATION** for authority to proceed with, and for an appropriation to cover the cost of Additions, Betterments, Replacements and Repairs, should be made on this form when the proposed work involves an expenditure of $200 or over. This form should be prepared in quadruplicate.

2. **ADDITIONS** include additional structures, facilities or equipment not taking the place of anything previously existing.

   BETTERMENTS include the enlargement or improvement of existing structures, facilities or equipment.

   REPLACEMENTS include all substitutions for capital exhausted or become inadequate in the service, the substitutes having substantially no greater capacity than the things for which they are substituted.

   When a substitution exceeds the capacity and cost of that substituted, any increased cost of the thing substituted over the cost of an exact replacement is considered a Betterment.

   REPAIRS include the replacement of any part of any structure, facility or unit of equipment, which through wear and tear becomes necessary, where such replacement does not amount to a substantial change of identity of such structure, facility or unit of equipment.

3. Forms A–1 and A–2 should be prepared in quadruplicate and accompany this form.

4. Except in cases of emergency, authority should be obtained before work is commenced. The general scheme of work should be adhered to. If alteration is necessary, permission to amend the original authorization should be obtained in the same manner as for original work.

5. A full and complete narration of the circumstances which necessitate the expenditure should be given grouped as far as possible in the following order.

   (*a*) NECESSITY FOR THE WORK.
   (*b*) DESCRIPTION OF THE WORK.
   (*c*) ADVANTAGES TO BE GAINED.
   (*d*) SAVING (IF ANY) TO BE EFFECTED.

   Blue-prints, drawings, diagrams and sketches, when necessary to illustrate the narrative, should accompany the application.

6. Salvage material returned to stores during the performance, or at the completion of the work, should be reported on Form A-6, specifying the A. F. E. account number to be credited.

7. When the work covered by this authority is completed, the salvage material returned and the final entries issued in connection with the A. F. E. account, the Comptroller should be notified on Form A-4.

Reverse Side Form-3

DESCRIPTION OF PROPOSED WORK

Form A-3 continued.

Form A–4 (Size 8½ x 11) **ORIGINAL**

AMERICAN ELECTRIC RAILWAY COMPANY

NOTIFICATION OF COMPLETION OF WORK

Covered by Application No.....

Office of..... Date.....

Address.....

To the Comptroller

American Electric Railway Company

8 West 40th Street

New York City

I hereby report that the.....

.....

.....

.....

has been completed and the Salvage returned to Stores.

No further charges or credits will therefore be issued in connection with the above work which was authorized by A. F. E. No.....

.....

Form A–5 (Size 8½ x 11) **ORIGINAL**

AMERICAN ELECTRIC RAILWAY COMPANY

ACCOUNTING DEPARTMENT

New York City

Final Accounting on A. F. E. No.....

..... Date.....

.....

The work authorized under A. F. E. No..... having been completed, the account is now closed and the net amount expended disposed of as follows:

Amount Authorized $.....

Total Amount Expended.....$

Distributed

To.....

To.....

To.....

To.....

To.....

To.....

To.....

TOTAL.....

The amounts charged to Maintenance Accounts appear on statements as follows:

.....$.....

.....$.....

.....

Comptroller.

(Form A-5)

Form A–6 (Size 8½ x 11) **ORIGINAL**

AMERICAN ELECTRIC RAILWAY COMPANY

REPORT OF SALVAGE MATERIAL RETURNED TO STORES APPLYING TO A. F. E.

No.....

Office of..... No.....

Address..... Date.....

	Original Cost	Present Value

Signed

.....

The known or estimated original cost must be shown against articles, the original value of which exceeded $10.00. State whether the cost is known or estimated.

(OVER)

Obverse Side Form A-6

INSTRUCTIONS

(1) This form should be prepared in triplicate, the original being forwarded to the Accounting Department, the duplicate to the General Storekeeper and the triplicate retained on file for reference.

(2) Salvage material returned to stores either during the performance or at the completion of work covered by an authority for expenditure should be reported upon this form.

(3) Credit to the A. F. E. account will be made on Transfer Bills.

(4) The present value is subject to criticism by the General Storekeeper, and the Accounting Department will finally determine the salvage value to be credited.

Reversed Side Form A–6

Form B–1 & 2 (Size 8½ x 11)

AMERICAN ELECTRIC RAILWAY COMPANY

New York City

ESTIMATE SHEET

Job No.....
Auth. No.....
Acct. No.....
Est. No.....

Department.....Date.....

Location.....Line.....

Estimated Cost of Labor and Material.....

.....

Reason for Work.....

.....

Present Construction.....

.....Date Laid.....Estimated Remaining Life.....

Proposed Construction.....

.....

Quantity	Item	Unit price	Additions	Betterments	Replacements	Operating Expenses
	Total					
	Grand Total...					

Additions
Betterments
Replacements
Operating Expenses

Recommended by.....
Approved by.....*Gen. Mgr*
Charges Approved by.....*Auditor.*

(over)

Obverse Side of Form B-1 and 2

Actual or Estimated Original Physical Cost of Structure to be Improved or Replaced

Quantity	Item	Unit price	Labor and material	Scrap or salvage credits

Actual cost of work done under this estimate

Reverse Side Form B-1 and 2

Form B–3 (Size 8½ x 11)

AMERICAN ELECTRIC RAILWAY COMPANY

New York City

Dated..... Estimate No.....

DISTRIBUTION

Acct. No.	Account	Additions	Betterments	Replacements	Operating expenses	Individuals and companies
	Total					

	Dr.	Cr.

In all vouchers and reports refer to **Authorization**

No.....

Charges Approved:

.....

General Auditor

Date..... Correct

Date..... Approved

Vice-President
General Manager

Date..... Approved

President

(OVER)

Obverse Side Form B-3

Give here original or estimated original cost of buildings or other structures that are to be improved or replaced.

Installed.....
Remarks.....
Estimated Life.....

Description		Disposition

INSTRUCTIONS FOR USING THIS BLANK

(1) When estimate is based upon plans, always refer to numbers and dates of plans first.
(2) Observe the following rules in describing work:
  (a) When additional buildings or other structures are to be built, begin description with the word " New."
  (b) When building or other structure is to be built to replace an inferior one, or one of different kind, begin description with the word " Replacing."
  (c) In case of replacement, mention should be made of any variation from the original construction, such as:
    Substituting stone for frame building.
    Steel for wooden bridge, etc.
  (d) When building or other structure is reconstructed, restoring the original, use the word " Renewing."
  (e) Under other conditions use a suitable word, such as:
    Construction (New).
    Strengthening (Bridges).
    Changing (Tracks).
    Altering (Buildings).
(3) CREDITS: When including in the estimate material which is to be used in temporary work, allow in the estimate (under head of " Credits ") an amount to cover estimated value of material to be recovered.
(4) When plan provides for replacing inferior buildings or other structures with buildings or other structures of a superior kind, always give above in space provided, the original or estimated original cost of the buildings or other structures to be replaced. Give this information for each building or other structure separately.
(5) In " Disposition " space above, show disposition to be made of the abandoned buildings or other structures.
(6) DISTRIBUTION: All expenditures to be classified according to the Uniform System of Accounts, the total expenditures on account of additions, betterments and replacements to be charged to such accounts.
When any portion of an expenditure should be charged to individuals or companies, give dates of agreements, names of parties to whom bills are to be rendered and amounts chargeable to each. Indicate by a * items in the estimate that are to be billed.
7)(Four copies of this form are to be submitted by the Originating Officer to the Approving Officers. After the authorization has been made, the General Auditor will approve the distribution charges, retain one copy for his files, sending two copies to the Approving Officer and one to the Auditor.
(8) Number estimates consecutively, beginning with Number 1. When revising estimates after authorizations have been made covering original, the revised estimate should be given a new number.

Reverse Side Form B-3

Form B-4 (Size 8½ x 11)

AMERICAN ELECTRIC RAILWAY COMPANY

New York City

NOTICE OF COMPLETION

OF WORK COVERED BY

AUTHORIZATION NO.....

Description of work

Work Performed By ....

[Fill in name of contractor or state company force as case may be.]

Date Completed ..... 191..

State Whether any Invoices Covering Charges in Connection with this Work are Withheld Pending Adjustment, Specifying such.

Credit-Description and Value of Material not yet Returned to Storeroom.

.....

Dated .....191.... .....

[Title

NOTE.—Charges in addition to those specified above must be covered by an additiona authorization. Original copy of final inspection notice, properly filled out, must accompany this notice of completion.

Form B-7 (Size 8½ x 11.)

AMERICAN ELECTRIC RAILWAY COMPANY

New York City

CERTIFICATE OF COMPLETION OF AUTHORIZATION

COVERED BY FORMS B-1 AND 2

Authorization No. .....

Description of Work

Work Performed by .....
[Fill in name of contractor or state company force as the case may be.]

Date Completed .....

Correct, ...
[Title]

Approved, ...
[Title]

Gross Expenditures,	Authorized: $	Actual: $
Credits—Value of Material	Authorized: $	Actual: $
Individuals & Cos.,	Authorized: $	Actual: $
Net Expense to Company		$
Over Expenditures		
Cancelled Balance		$
Supplemental Auth.		
Plans Engineer's File No.		

Remarks:

(NOTE.—Actual expenditures must not exceed amount authorized. If actual expenditures exceed amount authorized additional authorization covering expenditures must be issued before Certificate is made.)

Correct, ...
Title

Approved, ...
Auditor

REVISION OF SUB-DIVISION OF OPERATING MAINTENANCE ACCOUNTS TO MEET THE INTERSTATE COMMERCE COMMISSION CLASSIFICATION OF JULY 1, 1914

The 1914 Convention of the Accountants' Association adopted the uniform system of accounts for electric railways as prescribed by the Interstate Commerce Commission, which became effective on July 1, 1914, as the Standard Classification of Accounts for this Association, and this Committee understands its duty to be to make a re-arrangement of the maintenance and operating sub-accounts under the same or similar accounts of the new classification. We therefore submit the following:

WAY AND STRUCTURES

1. **Superintendence of Way & Structures.**
   (No sub-divisions.)
2. **Ballast.**
   (No sub-divisions.)
3. **Ties.**
   (No sub-divisions.)
4. **Rails.**
   (No sub-divisions.)
5. **Rail Fastenings and Joints.**
   (No sub-divisions.)
6. **Special Work.**
   (No sub-divisions.)
7. **Underground construction.**
   (No sub-divisions.)
8. **Track and Roadway Labor.**
   (No sub-divisions.)
9. **Miscellaneous Track and Roadway Expenses.**
   (No sub-divisions.)
10. **Paving.**
    (No sub-divisions.)
11. **Cleaning and Sanding Track.**
    (No sub-divisions.)
12. **Removal of Snow and Ice.**
    (No sub-divisions.)
13. **Tunnels and Subways.**
    (No sub-divisions.)
14. **Elevated Structures and Foundations.**
    (No sub-divisions.)
15. **Bridges, Trestles and Culverts.**
    (No sub-divisions.)
16. **Crossings, Fences and Signs.**
    (No sub-divisions.)

17. Signal and Interlocking Devices.
(No sub-divisions.)
18. Telephone and Telegraph Lines.
(No sub-divisions.)
19. Miscellaneous Way Expenses.
(No sub-divisions.)
20. Poles and Fixtures.
(No sub-divisions.)
21. Underground Conduits.
(No sub-divisions.)
22. Distribution System.
(No further sub-divisions.)
23. Miscellaneous Electric Line Expenses.
(No sub-divisions.)
24. Buildings, Fixtures and Grounds.
2401 Car houses.
2402 Shops.
2403 General offices.
2404 Stations, waiting-rooms and platforms.
2405 Docks and wharves.
2406 Miscellaneous Buildings and structures.
25. Depreciation of Way and Structures.
(No sub-divisions.)
26. Other Operations — Debit.
(No sub-divisions.)
27. Other Operations — Credit.
(No sub-divisions.)
28. Equalization — Way and Structures.
(No sub-divisions.)

EQUIPMENT

29. Superintendence of Equipment.
(No sub-divisions.)
30. Passenger and Combination Cars.
Elevated, subway and interurban cars weighing over twenty-eight tons without load)
3001 Bodies: Painting, decorating and varnishing.
3002 Body fittings, including registers, sand boxes, sash, doors, glass, interior trimmings and upholstering.
3003 Bodies: Wood, iron and steel work, including foundation brake rigging, draw bars, etc.
3004 Truck repairs, including brake rigging.
(*a*) Truck repairs, including brake rigging, type X.
(*b*) Truck repairs, including brake rigging, type Y.
3005 Truck bearings.
3006 Brake shoes.

3007 Air brake equipment.
(*a*) Air compressor, including motor.
(*b*) Air piping, reservoirs, etc.
(*c*) Governors.
(*d*) Engineers' triple electro-pneumatic emergency valves, etc.
3008 Heaters.
3009 Repairs due to accidents.

(Prepayment and semi-convertible cars)

3011 Bodies: Painting, decorating and varnishing.
3012 Body fittings, including registers, sand boxes, sash, doors, glass, interior trimmings, and upholstering.
3013 Bodies: Wood, iron and steel work, including foundation brake rigging, draw bars, etc.
3014 Truck repairs, including brake rigging.
3015 Truck bearings.
3016 Brake shoes.
3017 Air brake equipment.
(*a*) Air compressors, including motors.
(*b*) Air piping, reservoirs, etc.
(*c*) Governors.
(*d*) Engineers' triple electro-pneumatic and emergency valves, etc.
3018 Heaters.
3019 Repairs due to accidents.

(Closed cars; double truck; other than those classified above)

3021 Bodies: Painting, decorating and varnishing.
3022 Body fittings, including registers, sand boxes, sash, doors, glass, interior trimmings, and unholstering.
3023 Bodies: Wood, iron and steel work, including foundation brake rigging, draw bars, etc.
3024 Truck repairs, including brake rigging.
3025 Truck bearings.
3026 Brake shoes.
3027 Air brake equipment.
(*a*) Air compressors, including motors.
(*b*) Air piping, reservoirs, etc.
(*c*) Governors.
(*d*) Engineers' triple electro-pneumatic and emergency valves, etc.
3028 Heaters.
3029 Repairs due to accidents.

(Closed cars; single truck)

3031 Bodies: Painting, decorating and varnishing.
3032 Body fittings, including registers, sand boxes, sash, doors, glass, interior trimmings, and upholstering.

3033 Bodies: Wood, iron and steel work, including foundation brake rigging, draw bars, etc.
3034 Truck repairs.
3035 Truck bearing.
3036 Brake shoes.
3037 .....
3038 Heaters.
3039 Repairs due to accidents.

(Open cars; double truck)

3041 Bodies: Painting, decorating and varnishing.
3042 Body fittings, including registers, sand boxes, sash, doors, glass, interior trimmings, and upholstering.
3043 Bodies: Wood, iron and steel work, including foundation brake rigging, draw bars, etc.
3044 Truck repairs.
3045 Truck bearings.
3046 Brake shoes.
3047 Air brake equipment.
(*a*) Air compressors, including motors.
(*b*) Air piping, reservoirs, etc.
(*c*) Governors.
(*d*) Engineers' triple electro-pneumatic emergency valves, etc.
3048 .....
3049 Repairs due to accidents

(Open cars; single truck)

3051 Bodies: painting, decorating and varnishing.
3052 Body fittings, including register, sand boxes, sash, doors, glass, interior trimmings, and upholstering.
3053 Bodies: Wood, iron and steel work, including foundation brake rigging, draw bars, etc.
3054 Truck repairs.
3055 Truck bearings.
3056 Brake shoes.
3057 .....
3058 .....
3059 Repairs due to accidents.

(Miscellaneous)

3061 Fenders: All types, passenger and combination cars.
(*a*) Projecting fenders.
(*b*) Wheel guards.
3062 Signs: All types, passenger and combination cars.
(*a*) Car signs, type X.
(*b*) Car signs, type Y.
3063 Transfer of trucks for purposes other than repairs: All types of passenger and combination cars.
3064 .....

3065 Wheels and axles: Elevated, subway and interurban cars weighing over 28 tons.
3066 Wheels and axles: Prepayment and semi-convertible cars.
3067 Wheels and axles: Other cars.

31. Freight, Express and Mail Cars.

3101 Bodies: Trucks and brakes, including painting.
3102 Shifting trucks for purposes other than repairs.

32. Service Equipment.

3201 Service car bodies, trucks and brakes, including painting.
3202 Shifting trucks for purposes other than repairs.

33. Electric Equipment of Cars.

3301 Elevated, subway and interurban cars weighing over 28 tons; control and electrical equipment exclusive of motors.
3302 Prepayment and semi-convertible cars; control and electrical equipment exclusive of motors.
3303 Closed cars and open cars (double truck); control and electrical equipment exclusive of motors.
3304 Closed cars and open cars (single truck); control and electrical equipment exclusive of motors.
3305 Freight, express and mail cars: Control and electrical equipment exclusive of motors.
3306 Service cars: Control and electrical equipment exclusive of motors.
3307 Shifting electrical equipment for purposes other than repairs.
3308 .....
3309 .....
3310 .....
3311 Motors:
(*a*) Repairs to motors, type X.
(*b*) Repairs to motors, type Y.
(*c*) Repairs to motors, type Z.

34. Locomotives.

3401 Electric locomotive bodies, trucks and brakes, including painting.
3402 Steam locomotives.
3403 Shifting trucks for purposes other than repairs.
3404 .....
3405 .....
3406 Control and electrical equipment exclusive of motors.
3407 Motors (sub-divided by types).
3408 Shifting electrical equipment for purposes other than repairs.

35. Floating Equipment.
(No sub-divisions.)

36. Shop Equipment.
3601 Power drive, including steam equipment, motors, shafting, belting, etc.
3202 Machines, including lathes, drill presses, planers, wheel presses, grinders, etc.
3603 Miscellaneous equipment, including fire protection, cranes, telphers, etc.

37. Shop Expenses.
3701 Heating expenses.
3702 Lighting expenses.
3703. Miscellaneous supplies and expenses, including small hand tools.

38. Vehicles and Horses.
3801 Horse vehicles: Repairs and painting.
3802 Automobiles: Repairs and painting.
3803 Automobile supplies.

39. Miscellaneous Equipment Expenses.
(No sub-divisions.)

40. Depreciation of Equipment.
(No sub-divisions.)

41. Equipment Retired.
(No sub-divisions.)

42. Other Operations — Debit.
(No sub-divisions.)

43. Other Operations — Credit.
(No sub-divisions.)

44. Equalization — Equipment.
(No sub-divisions.)

POWER

45. Superintendence of Power.
(No sub-divisions.)

46. Power Plant Buidings, Fixtures and Grounds.
4601 Power plants.
4602 Sub-stations.

47. Power Plant Equipment.
4701 Engines, turbines.
(*a*) Engines.
(*b*) Turbines.
4702 Boilers, including furnaces, stokers and settings.
(*a*) Furnaces, including grates and grate supports.
(*b*) Stokers.
(*c*) Boiler settings.
(*d*) Boiler repairs.

4703 Pipe system, including steam, exhaust, oil, air and gas pipes, all fittings, valves and coverings.

4704 Auxiliaries, including economizers, condensers, cooling towers, ash and coal elevators, other elevators, etc.

(*a*) Pumps.
(*b*) Economizers.
(*c*) Condensers.
(*d*) Heaters.
(*e*) Ash and coal machinery.
(*f*) Cooling towers.
(*g*) Miscellaneous auxiliary repairs.

4705 Electric plant.

(*a*) D.c. generators.
(*b*) A.c. generators and compensators.
(*c*) Exciters.
(*d*) Rotary converters.
(*e*) Transformers and cooling systems.
(*f*) Switchboards, including bus bars, oil switches, and instruments.
(*g*) Storage batteries and charging outfits.
(*h*) Wiring.
(*i*) Miscellaneous electrical items.

4706 Miscellaneous, including such items as steam gauges, steam and water meters, feed water controllers, damper regulators and similar devices.

(*a*) Cranes, hoists, etc.
(*b*) Miscellaneous steam instruments, etc.

48. Sub-station Equipment.

4801 Electric plant.

(*a*) Rotary converters.
(*b*) Transformers and cooling systems.
(*c*) Switchboard, including bus bars, oil switches and instruments.
(*d*) Storage batteries, including charging outfit.
(*e*) Wiring.
(*f*) Miscellaneous electrical items.

4802 Miscellaneous sub-station maintenance.

(*a*) Cranes and hoists.
(*b*) Air compressors, vacuum cleaners, and other non-electrical devices.

49. Transmission System.

(No sub-divisions.)

50. Depreciation of Power Plant Buildings and Equipment.

(No sub-divisions.)

51. Equalization — Power.

(No sub-divisions.)

52. Power Plant Employes.
5201 .....
5202 Engine room labor.
5203 Boiler room labor.
5204 Producer room labor.
53. Fuel for Power.
5301 Coal.
5302 Natural gas.
5303 Fuel oil.
54. Water for Power.
(No sub-divisions.)
55. Lubricants for Power.
(No sub-divisions.)
56. Miscellaneous Power Plant Supplies and Expenses.
(No sub-divisions.)
57. Sub-station Employes.
(No sub-divisions.)
58. Sub-station Supplies and Expenses.
(No sub-divisions.)
59. Power Purchased.
(No sub-divisions.)
60. Power Exchanged — Balance.
(No sub-divisions.)
61. Power Transferred — Credit.
(No sub-divisions.)
62. Other Operations — Credit.
(No sub-divisions.)

CONDUCTING TRANSPORTATION

63. Superintendence of Transportation.
(No sub-divisions.)
64. Passenger Conductors, Motormen and Trainmen.
(No sub-divisions.)
65. Freight and Express Conductors, Motormen and Trainmen.
(No sub-divisions.)
66. Miscellaneous Car Service Employes.
(No sub-divisions.)
67. Miscellaneous Car Service Expenses.
6701 Lamps, waste and miscellaneous car supplies.
6702. Lubricants.
6703 Carbon brushes for motors.
6704 Miscellaneous supplies and expenses.
68. Station Employes.
(No sub-divisions.)
69. Station Expenses.
(No sub-divisions.)

70. Car House Employes.

7001 Elevated, subway and interurban cars weighing over 28 tons, car cleaning.

7002 Elevated, subway and interurban cars weighing over 28 tons, inspection and oiling.

7003 Prepayment and semi-convertible cars, car cleaning.

7004 Prepayment and semi-convertible cars, inspection and oiling.

7005 Closed cars other than classified above, car cleaning.

7006 Closed cars other than classified above, inspection and oiling.

7007 Open cars — car cleaning.

7008 Open cars — Inspection and oiling.

7009 Miscellaneous car house expense (not included in the above).

71. Car House Expenses.

7101. Heating.

7102 Lighting.

7103 Miscellaneous expenses, including water, fuel, etc.

72. Opreation of Signals and Interlocking Apparatus.

(No sub-divisions.)

73. Operation of Telephone and Telegraph Lines.

(No sub-divisions.)

74. Operation of Floating Equipment.

(No sub-divisions.)

75. Operation of Steam Locomotives.

(No sub-divisions.)

76. Freight and Express Collection and Delivery.

(No sub-divisions.)

77. Loss and Damage.

(No sub-divisions.)

78. Other Transportation Expenses.

(No sub-divisions.)

Inasmuch as there appears to have been made no sub-divisions of the Traffic and General Expense accounts, it is not thought necessary to repeat herein the captions given by the Interstate Commerce classification of the primary accounts, "Traffic" and "General and Miscellaneous".

Our study of the sub-divisions now set forth above under the new Interstate Commerce headings has impressed us with a doubt as to the value of such minute detail and intricate sub-divisions, but we have not felt justified under our instructions in making any amendments or simplifications. We recommend, however, that the matter of operating and maintenance account sub-divisions be given further study by future committees with a view of simplification.

DEVELOPMENT OF A PROPER LEDGER LOOKING TOWARDS THE MAINTENANCE OF A CONTINUOUS INVENTORY

The term "continuous inventory" we understand to mean a record of stock materials on hand which shall at all times be so nearly correct as to obviate the necessity of taking periodical inventories for the purpose of adjusting the records to conform with the facts. Our instructions were to develop a proper ledger looking towards the maintenance of a continuous inventory, but as, admittedly, a ledger is after all nothing more than a final summary, we have taken upon ourselves the duty of briefly outlining a system of blanks leading up from original records of transactions to the final tabulation of results on a ledger page, and obviously, the accuracy with which the transactions are recorded governs the value of the final results.

A prime requisite for the maintenance of a continuous inventory is adequate, convenient and safe store-keeping facilities, not only safeguarding more or less expensive materials from theft, but from hurried appropriation for legitimate purposes without proper record. We all know that when an emergency arises the maintenance or construction man knows no store-keeping laws, unless he is brought face to face with a locked door. We will take this opportunity to say, however, that no accounting "red tape" should be allowed to stand in the way in a real emergency, and it is much to be preferred that some materials should be missing than that some disaster should be occasioned by a too rigid adherence to accounting rules. Such cases, however, almost always can be satisfactorily met if all concerned are willing to coöperate, and if promptly attended to after the emergency has passed, it is not usually difficult to pick up the loose ends and complete the records after the fact.

In no department of railroad operation more than in a store-keeping department is it true that "order is Heaven's first law", and if order is not preserved a condition just opposite to Heaven usually prevails.

Adequate receptacles, such as boxes, bins, or what not, should be provided, and should be designed to meet the necessities of the various kinds of materials to be stored within them, and each bin should be numbered very distinctly. As far as is possible, similar kinds of materials should be stored in adjacent bins. It is also important that an agreed upon classification of materials should be compiled, using authoritative names so as to avoid confusion in terms. In our opinion this classification should be in great detail, as we believe it is a mistake to try to call too many things by the same name.

Firmly attached to each bin or receptacle should be a "bin card" (Form 2) on which should be shown the bin number and the store-keeper's stock card number (Form 3), as well as the various numbers of the purchasing agent's orders on which the particular kind of material has from time to time been ordered. On the bin cards the

store-tender should with scrupulous care and promptness, tally the quantities of materials deposited in each bin. This record should be made at first hand and with reference only to the actual physical count or measurement of the materials themselves, and without reference to some previous record of receipt. Simultaneously with the recording on the bin card of the receipt of stock materials, a record of the receipt of those materials should be compiled in some form of receiving book, and as a convenient form of loose-leaf record of receipts, we submit herewith Form 1.

The receiving ticket (Form 1) should set forth the following particulars: date of receipt, route by which shipment has been received, name of the seller, the quantity and unit of quantity, and description of the material. It should also show the number of the bin into which the material has been placed, and the stock card number. Space is also provided in which to indicate, if desirable, the requisition or storehouse order number, and the purchasing agent's order number. The receiving ticket should also embody a certificate on the part of the receiving clerk that he has weighed or counted the materials covered by it, and that the amounts entered are correct, and needless to say, this record should be so scrupulously correct as to preclude any subsequent disputes with shippers as to receipt of materials.

In the storekeeper's office should be kept a card record of the materials carried in stock, a separate card being kept for each bin. As a sample of such card record, we submit Form 3, on which is indicated the number of the bin, and the classification and name of the material. These stock cards are numbered consecutively, and in a prominent place at the top should be indicated the maximum and minimum quantities of that particular kind of material to be carried in stock. This has been found to almost automatically regulate the quantities of stock materials, preventing an over-stocking, as well as avoiding the possibility of running out of that kind of material. It will be noted that the stock record card does not provide for the carrying of money value balances. On it are indicated with respect to receipts, the dates received, the purchasing agent's order number, the requisition number, and sundry other reference numbers, as well as the name of the shipper, quantities, units of quantities, and unit prices.

To return to the bin card (Form 2), we direct your attention to the fact that the blank space provided for tallying should be utilized for recording disbursements as well as receipts, and the tally of the quantity on hand as indicated by the bin card should at all times agree with the actual quantity of the material contained within the bin. Upon the accuracy with which this record is kept in a large measure depends the subsequent accuracy of all records, and the duty of painstaking care in this particular cannot be too strongly impressed upon the store-tenders, who should immediately report any discrepancies which they find, in order that prompt adjustment may be made.

No material should be disbursed without proper order or requisition duly signed by proper authorities, and as suitable forms we submit Forms 4 and 5, the former being a straight storehouse order calling for date, quantity and units of quantity, and description of materials required, and indicating expense or other account number to be charged with the materials. As this order is filled by the store-tender, he should mark in the space provided the bin number from which the materials have been disbursed (the use of the other columns and spaces provided on the storehouse order will be hereinafter described). Form 5 is a requisition for material calling for approximately the same information, but addressed to the purchasing agent as well as to the storekeeper. This form may be accepted by the storekeeper as a straight storehouse order provided he has in stock the particular kind of material for which it calls, or if he has not such materials in stock or "something just as good", and it is not thought best to carry them regularly, this requisition may be forwarded forthwith to the purchasing agent as his authority for buying the materials to be subsequently charged directly to the job without passing through the stores accounts.

From the storehouse order (Form 4), or the requisition for material (Form 5), in the storekeeper's office, a record of the disbursements is entered on the credit side of the stock card (Form 3), showing the following detail: date of issue, book and order number of the storehouse order, and the requisition number, the distribution of accounts, and the quantity, units of quantity, and unit price of the material disbursed. It will also be observed that the stock card (Form 3) provides a column in which to indicate the balance in quantities of the materials on hand, and it will be obvious that the balances on these cards should at all times agree with the balances indicated upon the bin cards (Form 2).

The receiving tickets (Form 1), after entry upon the debit side of the storekeeper's stock card (Form 3), should be attached to the shipper's invoice, covering the materials, and should be forwarded to the accounting department. Likewise, the storehouse orders (Form 4), and the requisition for materials (Form 5), which may have been honored by the storekeeper, are also forwarded to the accounting department, and these records form the bases of debits and credits in the final stock material ledger which should be kept in the accounting department.

Submitted herewith will be found (Form 6) a loose-leaf stock material ledger, which in its captions indicates bin numbers, stock card numbers, classification by names, which invariably should be identical with those indicated in the previously described records. In the accounting department on the debit side of the ledger are entered the receipts showing dates, purchasing order numbers or other reference numbers, names of shippers, quantities and units of quantities,

unit prices, and total values. These entries are based upon the original receiving tickets substantiated by the shipper's invoice, and should there be any discrepancy between the two, they should then be adjusted.

On the credit side of the stock material ledger (Form 6), should be entered the disbursements, indicating the dates, requisition or other reference numbers, quantities and units of quantities, unit prices, and total values, this record being compiled from the individual storehouse orders or requisitions, and at this point it is in order to note that the money values of each storehouse order or requisition are computed and extended in the accounting department, based on the unit prices paid as indicated on the debit side of the stock material ledger. Should the unit prices vary from time to time, a careful averaging of such prices will insure accurate valuations.

In the center column of the stock material ledger (Form 6), are provided spaces to indicate balances of the quantities and money, and from the previously described blanks it will be seen that the quantity balances of the stock material ledger should agree with the quantity balances indicated on the stock card (Form 3), and on the bin card (Form 2). To the extent that these balances are kept in agreement, depends the value of the stock material ledger as a continuous inventory, and a simple method of insuring this agreement is to make frequent tests in the following manner: the store-tender in honoring a storehouse order (Form 4), or a requisition (Form 5), indorses on the back of it the quantities remaining in the bin after he has made the disbursement. This storehouse order or requisition as it is entered on the stock card (Form 3)in the storekeeper's office, and subsequently on the stock material ledger in the accounting department, gives the stock card clerk and the stock ledger clerk an opportunity to compare the balance as indicated on the back of the blank with the balance as indicated by his stock card or stock ledger, as the case may be. This method is simple but very valuable, and it is important that it should not be neglected, and that frequent tests at irregular intervals should be made. It goes without saying that an opportune time for making such a test is when any particular kind of material runs low, thus avoiding the spending of too much time in making an actual count. It may appear that this method being so simple and yet involving a great many tests, there would develop a disposition on the part of store-tenders and recording clerks to neglect it or perform this work in a haphazard manner, but this is entirely a matter of supervision and administration, and your Committee has before it the records of one member company in which the system herein described, has obviated the necessity of taking a physical inventory for over seven years. During the year ended December 31, 1914, and covering transactions of receipts and disbursements aggregating $2,500,000, and involving a total stock value of approximately $300,000 of materials classified under several thousand different names,

the net adjustment of stock material values for the year only amounted to $85.00.

Objection may be raised at the outset that this is an expensive method, and takes much stationery and many clerks to keep it running smoothly, but, on the other hand, consider the expense and annoyance of taking a physical inventory once a year. We all know that when an inventory is taken everything else but the clock stops and all hands go forth to tally materials, everyone getting in everyone else's way, some materials are counted twice under different names, and some are not counted at all. With the best of care, prices are more or less haphazard, and finally the total inventory value having been arrived at, the executive, the operating official, and the accounting officer have a "blue funk" when it is found necessary to "soak" the income account with a big adjustment in stock material values. *Query:* Which is the cheaper, a continuous inventory or the oldtime periodical "nightmare"?

Your Committee feels in submitting the foregoing as an outline of a storekeeping system designed to maintain a continuous inventory, that it is not offering any new discovery or radical departure from long recognized principles, but that it presents to the Association a carefully systematized chain of records in most respects identical with records that are now being kept by most companies, but we urge upon your consideration our belief that the secret of success in the operation of a system such as we have submitted is the personal element, and in bringing this report to a close, we reiterate the statement which we made in the beginning — that the value of the final result depends almost entirely upon the careful, prompt and painstaking accuracy with which the initial records and the subsequent entries are made.

Form 1 (Size 8½ x 11) **ORIGINAL**

AMERICAN ELECTRIC RAILWAY COMPANY

New York City

RECEIVING TICKET

.....**Storehouse**

Date Received.....

Shipped Via.....

Received from.....

B .....

Quantity	Unit	Description	Placed in bin number	Card number	Requisition or store order number	P. A. order numbe

I have weighed or counted the above and amounts entered are correct.

Checked on order by..... Signed.....

Order Clerk. *Receiving Clerk.*

Date.....

Receiving Ticket No.....

Form 1. Showing Receiving Ticket.

BIN TAG

Form 2 (Size 4 x 6)

BIN No. CAT. No.....

..... PAT. No.....

Article .....

Size
Quality } .....

.....

RECEIVED		DISBURSED					
Date	Quantity	Date	Quantity	Date	Quantity	Date	Quantity

(Same on reverse side.)

Form 3 (Size 11 x 7½)

AMERICAN ELECTRIC RAILWAY COMPANY

Maximum.....
Minimum.....

MATERIAL.....

Bin No.....
Card No.....
.....

RECEIPTS											DISBURSEMENTS								
Date received	Order No.	Req. No.	Item No.	Report No.	Bill No.	Shipper	Quantity	Unit	Price per unit	Balance Quantity	Balance Unit	Date issued	Book No.	Order No.	Req. No.	Charge Acct. No.	Charge Div.	Quantity	Unit	Price

CARRIED OVER

Note: Reverse side shows same columns.

Form 4 (Size 9 x 4⅜)

ORIGINAL

AMERICAN ELECTRIC RAILWAY COMPANY

STOREROOM ORDER

Book No..... Order No..... Date.....191.....

Quantity	Unit	DESCRIPTION	Bin	Card	Price	Amount		Charge account	
					Total				

Filled by..... Received by.....

Credit account..... Signed.....
Foreman

Approved.....
Superintendent

Form 5 (Size 8½ x 11) **ORIGINAL**

AMERICAN ELECTRIC RAILWAY COMPANY

REQUISITION FOR MATERIAL

Office of.....Date.....Req. No.....

Address.....Requisition for.....
(State whether Storehouse Stock or Direct Charge.)

Number items consecutively. Mark urgent items "RUSH." Requisitions covering material for general stock to be based on thirty days' consumption and issued on or before the last day of the month preceding that for which supplies are required.

To the Purchasing Agent or General Storekeeper

The following described material is required, same to be consigned as follows (give full shipping directions):

.....

.....

Items for delivery at different points must not appear on same requisition

Item	Quantity required	Material	Account to be charged	This column to be filled in by purchasing agent Firm and order No.

Approved Signed

....

Form 6 (Size 19 x 10½)

AMERICAN ELECTRIC RAILWAY COMPANY

New York City

Bin No...... **Card No.**..... **Classification**.....

.....

.....

.....

RECEIPTS								BALANCE ON HAND			DISBURSEMENTS						
Date	References		Shipper	Quantities		Price Per Unit	Value	Quantities		Value	Date	References		Quantities		Price Per Unit	Value
	P. A. Order	Audit No.		Number	Unit			Number	Unit			Req'n No.	Audit No.	Number	Unit		

In bringing to a close the report of the Committee on Engineering-Accounting for 1915, we wish to convey to our respective Associations the thought that the subjects herein discussed are of too great importance and of larger scope than can be fully covered in the time available for one year's Committee work, and the further thought that the matter herein contained is more in the nature of suggestion than of the promulgation of any hard or fast rules or recommendations, and we believe that the further consideration of these subjects by subsequent Committees would be desirable.

Respectfully submitted,

M. W. Glover,
C. H. Lahr,
J. C. Collins,
H. A. Gidney,
Martin Schreiber,
C. H. Clark,
J. P. Ripley,
J. P. Barnes,
F. H. Sillick, *Co-Chairman,*
Charles Rufus Harte, *Co-Chairman,*
Joint Committee on Engineering-Accounting.

President Mitchell:— Gentlemen, the report of this joint committee is before you and is now open for discussion.

Discussion of Report of Committee on Engineering-Accounting

C. R. Harte:— There is one form that does not appear in either of these systems submitted, which in our own company has been found of great assistance, and that is a monthly statement of every authorization under way, which the accounting department renders to the engineering departments. Under our system all charges against an authorization must be passed upon by the official charged with the execution, bills from the outside being specifically approved before payment, while internal charges are spread upon the books subject to correction if the details are not properly distributed. To minimize clerical labor, the report to the officer merely states that for the week ending such and such a

date, authorization charges have been made as follows, giving under each authorization number the amounts charged to each sub-account. In the large majority of cases the officer can tell at a glance that the charge is or is not approximately correct; if there is any doubt in his mind he then calls upon the department which did the work for full details, and if it appears that there has been an error, the comptroller is so advised, with the corrected distribution; in the absence of advice the original distribution stands. At the end of the month the comptroller issues for each authorization, a statement showing, divided as to subaccounts, the original estimate, the charges for the month, and the total charges to date; this enables the engineer or other officer in charge to see at a glance whether there have crept into the account any items of magnitude which ought not to have gone in, and, on the other hand, to see whether any other items, which properly should have been included have been omitted.

All departments interested are thus kept in close touch with the situation, and any questions can be settled while the matters are fresh in mind.

A copy of the above mentioned form is shown on page 398.

C. R. HARTE:— Before taking up the next portion of the report I wish to put on record, so that it may have consideration by the Executive Committee, the fact that every committee should be charged with the duty of conferring, without specific instructions in each case, with any and every other committee likely to be interested in any subject upon which it is working. This joint committee had for one of its specific subjects the rearrangement of the uniform accounts subdivisions to correspond with the revised I. C. C. classification; and had it known that the Committee on Power Generation was engaged on the further subdivision of some of the operating accounts the latter work could have been harmonized with the general scheme; as it was, your joint committee knew nothing of this until the advance papers came out, and it was too late to do anything. The subdivisions proposed are not on the same basis as our approved classification, the Committee on Standards has very properly referred the matter back for conference and adjustment with this Joint

THE CONNECTICUT COMPANY

New Haven, Conn., March 4, 1914

Chase Rolling Mill Extension

Appropriation No..... Length of Line: Main Line..... Sidings..... Total.....

Account	Estimate	Expended	Operating Charges		Additions and Betterments	C. and D. Recoll.
			Acct. No.	Amount		
ROAD						
651 Engineering and superintendence	$13,917 00	$11,520 08	1	$288 38	$10,581 70	$650 00
652 Right of way	22,510 00	24,735 49	....	.....	24,735 49	.....
653 Other land used in electric railway operations	.....	.....	....	.....	.....	.....
654 Grading	71,465 00	88,637 50	....	.....	87,554 05	1,083 45
655 Ballast	5,860 00	8,652 13	....	.....	8,652 13	.....
656 Ties	9,142 00	5,832 66	3	1,777 54	3,335 64	719 48
657 Rails, fastenings and joints	23,660 00	23,659 17	4	3,460 53	16,932 83	3,011 47
			5	256 96	.....	2,635 15
658 Special work	15,750 00	11,370 51	6	1,777 54	6,957 82	.....
659 Underground construction	.....	.....	....	.....	.....	.....
660 Paving	7,546 00	5,219 54	9	2,070 64	2,304 42	844 48
661 Track laying and surfacing	14,500 00	13,398 80	8	2,801 61	9,469 34	1,334 06
662 Roadway tools	.....	154 86	....	.....	154 86	.....
663 Tunnels	.....	.....	....	.....	.....	.....
664 Elevated structures and foundations	.....	.....	....	.....	.....	.....
665 Bridges, trestles and culverts	8,510 00	5,609 74	....	.....	4,415 38	1,194 36
666 Crossings, fences, cattle guards and signs	4,560 00	3,832 56	....	.....	3,832 56	.....
667 Interlocking and other signal ap.	2,500 00	510 15	....	.....	510 15	.....
668 Telegraph and telephone lines	.....	264 01	....	.....	264 01	.....
669 Poles and fixtures	7,200 00	6,342 36	....	.....	5,914 71	427 65
670 Underground conduits	.....	.....	....	.....	.....	.....
671 Transmission system	.....	.....	....	.....	.....	.....
672 Distributing system	49,360 00	34,382 52	23-c	587 16	32,038 89	1,756 47
673 Dams, canals, and pipe lines	.....	.....	....	.....	.....	.....
674 Power plant buildings	.....	.....	....	.....	.....	.....
675 Substation buildings	.....	.....	....	.....	.....	.....
676 General office buildings	.....	.....	....	.....	.....	.....
677 Shops and car houses	.....	.....	....	.....	.....	.....
678 Stations, waiting rooms and miscellaneous buildings	.....	.....	....	.....	.....	.....
679 Docks and wharves	.....	.....	....	.....	.....	.....
680 Power plant equipment	.....	.....	....	.....	.....	.....
681 Substation equipment	.....	357 77	....	.....	357 77	.....
682 Shop equipment	.....	.....	....	.....	.....	.....
683 Park and resort property	.....	.....	....	.....	.....	.....
684 Cost of road purchased	.....	.....	....	.....	.....	.....
688	.....	2 62	*	.....	.....	.....
8	.....	141 37	†	.....	.....	.....
62	.....	64 84	†	.....	.....	.....
GENERAL EXPENDITURES						
690 Law expenses	2,320 00	.....	....	.....	.....	.....
691 Interest	.....	.....	....	.....	.....	.....
692 Injuries and damages	.....	3 00	....	.....	3 00	.....
693 Taxes	.....	.....	....	.....	.....	.....
694 Miscellaneous	.....	.....	....	.....	.....	.....
Totals	$258,800 00	$244,691 68	....	$13,020 36	$218,014 75	$13,656 57
Per mile of main track	.....	.....	....	.....	.....	.....

* Included in Acct. No. 5.
† Included in Acct. No. 8.

Remarks:

.....
.....
.....

Committee, and a year must elapse before the matter can come up for action. With standing instructions for conference with related committees such a slip up would be guarded against.

PRESIDENT CRECELIUS:— For Mr. Harte's information I would say that the recommendation of the Committee suggesting further consideration of this matter will be automatically taken care of by the approval of this report by the Convention.

J. H. NEAL:— I want to ask if it is the thought that this scheme should be adopted and recommended for use? If so, then I shall have something to say against it.

C. R. HARTE:— Let me say for the benefit of those who have just come in, that the Joint Committee has carried out its specific instructions to revise the uniform subaccounts to correspond with the I. C. C. classification, but while it recognizes the desirability of uniformity in such subdivisions as may be employed it does question the wisdom, except possibly for some of the largest companies, of employing such minute subdivisions, and it urges further study, particularly with reference to possible simplification.

PRESIDENT MITCHELL:— If there is no further discussion on this part of the report we will take up the matter which appears on page 385, under the title "Development of a Proper Ledger looking towards the Maintenance of a Continuous Inventory."

PRESIDENT CRECELIUS:— Mr. Harte, will you kindly explain this section of the report, that it relates purely to storeroom supplies.

C. R. HARTE:—That is the continuous inventory statement?

PRESIDENT CRECELIUS:— The action of the Committee with regard to confining it to stock materials only.

C. R. HARTE:— The question was raised, when your Committee first studied the proposition, as to just what was meant by this term "continuous inventory." There was difference of opinion as to whether it referred to a continuous inventory of stock materials, or whether it meant an inventory of the entire property, and the matter was submited to the Executive Committee which advised that the instructions had reference specifically and particularly to the former and for that reason the third section of the report was confined to stock materials.

PRESIDENT CRECELIUS:— In regard to the matter just mentioned by Mr. Harte, I will say that the Executive Committee of the American Association recently reconsidered its action in regard to the definition of the subject matter of "a continuous property inventory," and it will now be, as it was originally intended to be, made to include the subject of a "continuous property ledger" which will be a new subject for the Joint Committee for next year's work, together with the subdivision of power plant accounts, which suggestion has been brought forward by the Committee on Power Generation.

C. R. HARTE:— I think it may be of interest to bring out one point specifically. Of course everybody is supposed to have read the report, but doubtless some of us have not had the opportunity, and there is one little statement regarding this continuous inventory to which I particularly call attention. It is on page 388 and is as follows: "Your committee has before it the records of one member company in which the system herein described, has obviated the necessity of taking a physical inventory for over seven years. During the year ended December 31, 1914, and covering transactions of receipts and disbursements aggregating $2 500 000, and involving a total stock value of approximately $300 000 of materials classified under several thousand different names, the net adjustment of stock material values for the year only amounted to $85.

PRESIDENT MITCHELL:— Is there any further discussion? If not, you will please state what action shall be taken on the report.

C. R. HARTE:— I move that this report be received and filed.

(Motion duly seconded, stated and carried.)

PRESIDENT MITCHELL:— I will ask the Acting-Secretary to present the Report of the Joint Committee on Life of Railway Physical Property. The co-chairmen of this Committee are Mr. R. N. Wallis, of Fitchburg, Mass., and Mr. Martin Schreiber, of Newark, N. J. Neither of whom are present.

REPORT OF THE COMMITTEE ON LIFE OF RAILWAY PHYSICAL PROPERTY

To the American Electric Railway Engineering and Accountants' Associations:

GENTLEMEN.— Your Committee has not deemed it necessary to take up during the past year any new phases of the subject which has been referred to it.

We are coöperating with the Sub-committee on Bibliography of the Committee on Valuation of the American Association and expect later to furnish members with a bibliography of the subject assigned to us which will bring our 1912 list down to date.

Past endeavors have convinced the Committee that any attempt to collect from member companies data concerning the life of railway property which can have any ultimate value is merely a waste of effort, at least until such time as data concerning actual conditions shall have been gathered and has stood the test of varied and conclusive experience.

The complicated character of the factors which enter into the life of railway physical property has been thoroughly discussed by the Committee in its 1913 report.

Therein the Committee set forth the following "basic elements which affect the usefulness of such property.

(*a*) Use
(*b*) Climatic and Soil Conditions
(*c*) Maintenance
(*d*) Inadequacy
(*e*) Obsolescence
(*f*) The Human Element
(*g*) The Public Demand
(*h*) Earnings"

A study of this list and a consideration of the further complications and variations resulting from local conditions are sufficient to demonstrate the futility of attempting to gather figures of the life of railway property which shall be generally applicable, or which may be "averaged" or "compiled" or even "compared" except after the fashion of "rule of thumb."

For reasons which this Committee has previously discussed, it appears utterly futile to attempt to gather together the experience in regard to a great number of units after the manner of human mortality tables. It is mere guesswork to fix the time when any given unit will go out of service, and therefore idle to construct any scientific conclusions upon such a basis.

It may be argued that, as with human life tables, it is possible to take a large number of experiences, and by averaging them, secure an "expectancy." Even if that shall be true when the industry has

existed long enough to make available sufficient experience to form a basis for such expectancy, that time is still in the distant future. The youth of the art and its rapid development, affecting all its elements of physical property, make any experience so far obtained of little value in forming predictions regarding the future life or term of service of such property.

Therefore, in discussions of valuation or depreciation or replacement it must be borne in mind that any estimates of future life, whether specifically regarding an individual unit, or generally regarding a group, is at best a guess, and a very uncertain and inconclusive one.

This is merely reiterating what the Committee, in its earlier reports, has pointed out, with its reasons and in greater detail. It is some satisfaction for the Committee to note, therefore, that there seems to be increasing recognition on the part of regulating commissions, valuation experts and other authorities of the soundness of the position which the Committee has emphasized.

Less and less weight seems to be given to the theory that it is possible to predetermine how long a given unit of property is to continue giving service, either through an examination of its own condition or a comparison with other similar units, which, in other places and under other conditions (no matter how similar), may have completed their usefulness.

Such a process is at times necessary, but where necessary, is coming to be largely recognized as merely an estimate which is largely a matter of judgment rather than of scientific determination.

Your Committee recommends that a committee on the subject be continued for further study, to compile a bibliography, and to render such aid in behalf of the industry as circumstances may render necessary.

Respectfully submitted,

A. R. Patterson,
W. H. Forse, Jr.,
R. B. Rifenberick,
J. H. Hanna,
Robert N. Wallis, *Co-Chairman,*
Martin Schreiber, *Co-Chairman,*
Committee on Life of Railway Physical Property.

President Mitchell:— Gentlemen, the report is before you for discussion. If there is no objection, it will be received and placed on file.

Is there any further business to come before this joint session? If not, we stand adjourned.

(The meeting then adjourned.)

WEDNESDAY SESSION

October 6, 1915

President Crecelius called the meeting to order at 2:50 P. M.

President Crecelius:—The first matter to come before the meeting this afternoon is the approval of the amendments to the Constitution and By-Laws. They are shown in two pamphlets, which have been distributed, and are in your possession. I will ask the secretary to outline briefly what these questions are.

Acting Secretary Stocks:—On pages 404 to 405 are shown the changes in the constitution which were brought befor the 1914 Convention, but as they had not been sent out to the members thirty days prior to the meeting, as required by Article IV, they had to go over to this Convention for final adoption.

On page 405 there is a further amendment to Article III, same being a new paragraph to follow present paragraph (*b*), and which provides for Company Section Members.

It is presumed every one has read these proposed amendments, and these changes are simply made so that our Constitution will conform in detail with that of the American Association.

To the American Electric Railway Engineering Association:

Gentlemen:—The 1914 Executive Committee appointed a special committee to review the Constitution and By-Laws of the Engineering Association and recommend such changes as in their judgment seemed necessary with a view to eliminating certain inconsistencies in the language of the present Constitution and also make it agree with the Constitution of the American Association.

The changes in the By-Laws as recommended by the special committee were approved by the 1914 Convention but as it had been impossible to furnish copies of the proposed changes in the Constitution to company members thirty days in advance of the Convention, as required by Article IV of the Constitution relating to amendments, it was necessary that that portion of the Committee's recommendations relating to the Constitution be deferred for action by this Convention.

Therefore, in accordance with Article IV of the Constitution, the report of the special committee proposing certain amendments to the Constitution is herewith submitted.

Yours very truly,
E. B. Burritt,
Secretary.

CONSTITUTION AND BY-LAWS OF THE AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION

CONSTITUTION

I.— NAME

The name of the association shall be the "American Electric Railway Engineering Association" and its office shall be [at the place where the secretary resides] *located in the city of New York, N. Y.*

II.—OBJECTS

The objects of this association shall be to bring together those engaged in electric railway engineering with urban, interurban or the electrified sections of steam [railways,] *railroads* for the interchange of ideas, to acquire and distribute information and to promote uniformity of practice.

III.— MEMBERS

The membership of this association shall consist of two classes, as follows:

(*a*) [Active] *Company* members consisting of [active] *Company* members of the American Electric Railway Association. Each [active] *Company* member shall be entitled to one vote on all questions coming before [this] *the* association, which *vote* shall be cast by [a] *its* properly accredited [representative] *delegate, who is to be appointed* [of] *from* its mechanical, electrical, way or *other* engineering [departments] *department.* Each [active] *Company* member [shall send] *may be represented by* as many delegates from [the] *its* engineering departments as it may desire.

(*b*) [Associate] Members, consisting of [associate] *individuals who are* members of the American Electric Railway Association, *and* who [may elect] *have elected* to ally themselves with [this association] *the Engineering Association in accordance with the provisions of the constitution of the American Electric Railway Association.*

(*c*) *Members are not entitled to vote. They are entitled to hold office only if in the employ of company members. Except as otherwise provided for in the constitution of the American Electric Railway Association, the following privileges are accorded them:*

(1) The right to attend meetings of this association and to the floor of its convention.

(2) Eligibility to membership on committees.

(3) The right to receive a cloth-bound copy of the proceedings of this association.

(4) The right to receive other general publications, including AERA *and convention advance papers of this association.*

(5). The right to wear the official emblem of this Association.

IV.—AMENDMENT

This constitution may be amended by a two-thirds vote of the [members] *properly accredited delegates* present at a regular meeting, provided the proposed amendment shall have the approval of two-thirds of the Executive Committee, and provided also that a copy shall have been sent to each of the [active] *Company* members, at least thirty (*30*) days prior to the date of the meeting at which the proposed amendment is to be acted upon.

PROPOSED CHANGES IN CONSTITUTION AND BY-LAWS

To the American Electric Railway Engineering Association:

GENTLEMEN:— The Special Committee appointed by the American Association to consider the matter of dues of members (individual) who are members of Company Sections, has recommended that the dues of such members be reduced from $5.00 to $2.00 per annum.

The Executive Committee of the American Association has approved this recommendation and has instructed that an amendment to cover the recommendation be prepared and submitted for the approval of the company members with a view to its ratification by the Association at the coming Convention.

In order that the Engineering Association may meet this recommendation, it is necessary that its Constitution be changed accordingly. Therefore, by direction of the Executive Committee and in accordance with Article IV, I am submitting herewith, for your approval, a suggested form for such an amendment, to be known as paragraph (*c*):

> (*c*) *Company Section Members, consisting of Company Section Members of the American Electric Railway Association who may elect to ally themselves with this Association.*

Respectfully submitted,

E. B. BURRITT,
Secretary.

PRESIDENT CRECELIUS:— Gentlemen, as has been pointed out, these amendments to the Constitution and By-Laws are required in order to harmonize our Constitution with that of the American Association, and to have this new matter included in the classification of membership. These things have been submitted for your consideration for some time, and I doubt if it is necessary to have any considerable discussion, in view of the fact that the subject has already been under consideration. If there is no discussion, a motion to approve the amendments to the Constitution is in order.

C. R. HARTE:— I move that the amendments to the Constitution be approved.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next business in order will be the presentation of the report of the Committee on Power Generation. Unfortunately, we have no member of the Committee here, and our acting-secretary, will present the report.

REPORT OF COMMITTEE ON POWER GENERATION

To the American Electric Railway Engineering Association:

GENTLEMEN.— The Executive Committee of the Engineering Association assigned the following subjects for consideration by the Committee on Power Generation.

(a) Report on Good Practice in regard to smoke abatement from the standpoint of smoke observations and appliances and devices used for determining smoke density.

(b) Specification for Boiler Tubes, considering the question from the standpoint of both open hearth seamless hot drawn steel tubing and charcoal iron tubes.

(c) Specification for purchase of fuel and power station lubricants.

(d) Review all existing Standards and Recommendations originating with Committee on Power Generation.

(e) Consider the Standardization Rules of the American Institute of Electrical Engineers, so far as they affect the scope of your Committee. In the event that any rule is not approved, a recommended revision should be submitted.

(f) Consider the tentative Boiler Code of the American Society of Mechanical Engineers, with particular reference to the Specification for Lapwelded and Seamless Steel Boiler Tubes (set forth on page 212, preliminary draft third printing, and page 210, preliminary draft fourth printing).

It was suggested to the members of the Committee at the outset that the work this year should aim to make specific recommendations regarding Practice and Standards rather than to deal with the subjects under consideration in the form of papers. It was felt that only in this way could each subject be given the best thought and suggestion of the whole Committee. A tentative assignment of subjects was made by the Chairman with the above suggestion, and a meeting called in Cleveland on Friday, January 22nd, 1915, at the Hotel Statler.

Those present were: Messrs. L. P. Crecelius, R. J. S. Pigott, Fay Woodmansee, G. H. Kelsay, E. H. Scofield, W. H. Roberts, A. B. Stitzer and J. W. Welsh, *Chairman.*

In addition to the subjects suggested by the Executive Committee, Mr. E. H. Scofield suggested for consideration the subject of "Analysis of Costs of Power Station Operation."

At the Cleveland Meeting it was brought out in reviewing the work of previous Committees that former reports had consisted largely in the presentation of a number of very valuable papers and that the data contained therein was not always readily accessible as it would be classified in the Engineering Manual which so far does not contain any recommendation of the Committee on Power Generation. It was felt that it would be desirable if this work could be summarized with a view to presenting it to the Committee on Standards for adoption either as a "Standard" or "Recommended Practice."

In order not to undertake more than could be successfully accomplished, it was felt necessary to eliminate certain subjects assigned by the Executive Committee. A general discussion took place on each of the subjects and an outline was drawn up in each case dealing with the method to be followed.

As result of this discussion the following re-arrangement and assignment of subjects was made:—

(a) Analysis of Steam Power Station Costs.

SUB-COMMITTEE:— Mr. E. H. Scofield, *Chairman,* Messrs R. J. S. Pigott and G. H. Kelsay.

(b) A Consideration of the Boiler Code of the American Society of Mechanical Engineers and Specification for Boiler Tubes, considering the question from the standpoint of both open hearth seamless hot drawn steel tubing and charcoal iron tubes.

SUB-COMMITTEE:— Mr. R. J. S. Pigott, *Chairman,* and Mr. B. F. Wood.

(c) Specification for Purchase of Fuel.

SUB-COMMITTEE:— Mr. A. B. Stitzer, *Chairman,* Messrs Wm. Roberts and G. H. Kelsay.

(d) Specifications for Power Station Lubricants.

SUB-COMMITTEE:— Mr. Wm. Roberts, *Chairman,* and Mr. E. D. Smith.

(e) Consideration of the Standardization Rules of the American Institute of Electrical Engineers.

SUB-COMMITTEE:— Mr. Fay Woodmansee, *Chairman,* Messrs E. H. Scofield and J. W. Welsh.

The work of the Sub-Committees was carried on by correspondence and each Sub-Committee was successful in preparing a complete preliminary report previous to the final meeting of the whole Committee which was held in Pittsburgh on May 18, 1915 at the Fort Pitt Hotel.

Those present were:— Messrs. E. H. Scofield, A. B. Stitzer, G. H. Kelsay, W. H. Roberts, E. D. Smith and J. W. Welsh, Chairman.

Each Sub-Committee report was taken up in detail, criticized and corrected and the sub-committee instructed to re-write the report in line with the discussion of the whole Committee.

ANALYSIS OF STEAM POWER STATION COSTS

Introductory

It has been considered, by those responsible for the management and operation of electric power generating plants, that the system of accounts outlined by the Interstate Commerce Commission and adopted by the A. E. R. A. is inadequate for the purpose of analysis of the items of cost entering into such operation. The subject has been discussed to considerable extent in papers and communications to the various Engineering Societies and suggestions for detail subdivisions of operating accounts submitted, but as far as the Committee has knowledge no action has been taken toward establishing a standard system of detail accounts.

In addition to a system of detail accounts, there is required a system of keeping engineering and operating data records, also a method of study and analysis by which such records may be compared.

In order to bring this subject before the Association it, therefore, seems advisable that a tentative report be prepared and submitted to the 1915 Convention outlining a general scheme, to be worked out more in detail in a later report.

The purpose of such analysis is:

1. To provide means of knowing the actual performance of a plant.
2. To determine the effect of all fixed and variable factors in this performance.
3. To determine wherein the performance of one plant varies from another and the reason for such variation.
4. To establish standards of performance with which various plant performances may be directly compared.
5. To point out where to direct effort to improve plant operation.

The scope of the present report being, to outline a general scheme of analysis, detailing to some extent the items of information desired and suggesting a method of study outlining the factors to be considered and items of performance for which standards may be established.

With this report before the general organization, it is hoped that considerable information and discussion may be called forth.

Subdivision of Accounts

(This section of report to be submitted to Committee on Engineering-Accounting)

The report is confined to what is termed the Cost of Manufacture of Steam Power, and includes only such items as refer to steam power plant under the I. C. C. classification numbers (45, 46, 47, 50, 52, 53,

*See page 451 for action of Committee on Standards.

54, 55 and 56). All definitions appearing in the I. C. C. classification to apply under the subdivision classificaton. The scheme of numbering employed is to use the I. C. C. number as the initial number adding a sub-number, according to the Dewey or other approved system.

All items of maintenance should be separated into labor and material. Also it will be found that some items, particularly of equipment maintenance, should be further subdivided as to individual unit accounts. Such subdivision, however, will be special for each plant, and need be carried out only so far as may be necessary for comparing the performance between various units.

The information required for compiling these accounts must be furnished from the operating plant, and preferably under the supervision of the accounting department. All material should be drawn from stock on material slips and all labor time reported on time slips, each slip bearing the subdivision account number and indicating, where required, the operating unit on which work is done or material used. Monthly reports are compiled from these slips by the accounting department, and other general expenses, not included on these slips, added. A copy of this report should be furnished the engineering department, from which may be compiled such records of performance and costs, as are required for future reference.

A list of subdivision accounts recommended follows:

SUBDIVISION OF OPERATING ACCOUNTS — STEAM POWER PLANT I. C. C. CLASSIFICATION

45. Superintendence of Power (Management):

.1 Superintendence — plant engineer and assistants
- .11 Superintendence of plants.

.2 Engineering — department office employes
- .21 Engineering and drafting

.3 Testing — laboratory and plant work, instruments and supplies
- .31 Chemicals and laboratory
- .32 Testing mechanical equipment
- .33 Testing electrical equipment

.4 Records — clerical work, furnishings and supplies
- .41 Statistics
- .42 Keeping logs and records
- .43 Timekeeping
- .44 Storekeeping
- .45 Miscellaneous office expenses (not under account 85)
- .46 Stationery
- .47 Telegraph and telephone (not under account 89)

46. Power Plant Buildings, Fixtures and Grounds (Maintenance — labor — material)

.1 Grounds
- .11 Grading, lawns, driveways, walks, fences, etc.

.2 Main building —
- .21 Foundations, masonry and walls
- .22 Steel structures
- .23 Roofs
- .24 Skylights, windows and louvers
- .25 Floors
- .26 Railings, stairways, doors, etc.
- .27 Painting
- .28 Coal bunkers and receiving hoppers

.3 House service apparatus
- .31 Elevators
- .32 Lighting
- .33 Heating and ventilating
- .34 Fire protection

.4 Other structures
- .41 Tracks and trestles
- .42 Coal storage yards, including bins, tunnels, etc.
- .43 Condensing water intakes and tunnel
- .44 Filter plant building
- .45 Storage building
- .46 Machine shop building
- .49 Miscellaneous

.5 Miscellaneous
- .51 Office furniture

47. Power Plant Equipment (Maintenance)—labor—material:

.1 Coal and ash handling, fuel oil or gas handling
- .11 Towers or cranes
- .12 Coal conveyors — ash conveyors
- .13 Crushers
- .14 Weighing apparatus
- .15 Coal spouts, gates and hoppers
- .16 Ash hoppers and gates — fine coal hoppers and gates
- .17 Coal or ash cars and locomotives
- .18 Oil handling apparatus (or gas)

.2 Boilers and furnaces
- .21 Furnace arches
- .22 Linings and bridge walls } fire brickwork
- .23 Baffles
- .24 Setting walls, brick
- .25 Steel framing for setting
- .26 Tubes and drums
- .27 Superheaters
- .28 Boiler fittings

47. **Power Plant Equipment (Maintenance)—labor—material:—** *Continued*

.3 Stokers, drives and grates
- .31 All parts not normally destroyed by fire
- .32 Burned parts (tuyeres, etc.)
- .33 Drive and air supply
- .34 Grate bars
- .35 Oil burners
- .36 Gas burners

.4 Stacks, flues and breechings
- .41 Flues, breechings and dampers
- .42 Flue gas cleaning apparatus
- .43 Stacks

.5 Pumps and heaters, etc.
- .51 Boiler feed pumps
- .52 Other service pumps
- .53 Draft fans
- .54 Feed water heaters
- .55 Economizers
- .56 Softeners
- .57 Filters
- .58 Evaporators
- .59 Boiler compound apparatus

.6 Prime movers and auxiliaries
- .61 Reciprocating engines
- .62 Turbines
- .63 Exciters, steam driven
- .64 Lighting sets, turbine and engine driven
- .65 Condensers
- .66 Cooling towers and sprays
- .67 Condenser auxiliaries
- .68 Oil pumps — filters — accumulators

.7 Piping and valves
- .71 H. P. main steam
- .72 H. P. aux. steam
- .73 L. P. steam and exhaust
- .74 H. P. water
- .75 L. P. water
- .76 Drainage
- .77 Oil system
- .78 Air system
- .79 Miscellaneous

.8 Generators and electrical equipment for power
- .81 Generators — main
- .82 Exciters and m. g. exciter sets — testing m. g. sets
- .83 Transformers and compensators

47. Power Plant Equipment (Maintenance)—labor—material:— *Continued*

.8 Generators and electrical equipment for power — *Continued*

.84 Oil switches
.85 Switchboards
.86 Instrument transformers
.87 Busses and compartments — reactance coils
.88 Batteries
.89 Cables

.9 Miscellaneous

.91 Signal system
.92 Elect. operation of valves, etc.
.93 Machine tools
.94 Cranes
.95 Air compressors
.96 Packing.

50. Depreciation:

.1 Buildings
.2 Mechanical equipment
.3 Electrical equipment

52. Power Plant Employes (labor):

.1 Boiler room general

.11 Engineers and assistants

.2 Boilers and stokers

.21 Water tenders
.22 Stoker operators
.23 Assistant stoker operators
.24 Firemen
.25 Assistant firemen or coal passers
.26 Boiler cleaners

.3 Pumps

.31 Feed pump men
.32 Oilers
.33 Test pumps

.4 Draft apparatus

.41 Forced draft fan men
.42 Induced draft fan men
.43 Flue gas cleaner men

.5 Feed water apparatus, other than pumps

.51 Heater cleaning
.52 Economizer cleaning and oiling
.53 Evaporator cleaning
.54 Water treating
.55 Boiler compound feeders
.56 Cooling tower attendants

52. Power Plant Employes (labor): — *Continued*

.6 Coal handling and ash handling
- .61 Weighers and crushing
- .62 Stocking
- .63 Rehandling
- .64 Ash conveyors and cars
- .65 Ash storage
- .66 Ash rehandling

.7 Engine room
- .71 Engineers and assistants
- .72 Turbine operators
- .73 Engine operators
- .74 Oilers, main units
- .75 Wipers main units
- .76 Pump men
- .77 Pump oilers

.8 Electrical operation (labor)
- .81 Chief operator and electrical superintendent
- .82 Switchboard men
- .83 Oil switch men
- .84 Dynamo tenders
- .85 Wiremen and lighting system

.9 Miscellaneous
- .91 Janitors
- .92 General cleaning

53. Fuel for Power (Material):

.1 Coal, Bituminous
.2 Anthracite
.3 Oil
} At station, including freight and switching

.4 Gas
.5 Ash removal from plant
.9 Miscellaneous

54. Water for Steam (Material—rentals and other expenses):

.1 Feed water
.2 Condensate
.3 Water purification and chemicals for treatment
.4 Condensing water and cooling towers, etc.
.5 Tunnel rentals
.9 Miscellaneous

55. Lubricants (material).

.1 Engine oil
.2 Turbine oil
.3 Cylinder oil
.4 Grease
.5 Graphite
.9 Miscellaneous

56. Miscellaneous Power Plant Supplies and Expenses (Material and other expenses):

.1 Waste
.2 Rags
.3 Fire room tools (hand)
.4 Lamps, brushes, fuses
.5 House water
.9 Miscellaneous

Engineering and Operating Data Records

The forms used for keeping records of engineering and operating data will vary in different plants, but, in general, the following items of information should be kept in such permanent form as is convenient for future reference and calculations.

A detailed inventory of the power plant building and equipment giving description, rated capacity and original cost is essential. A general description of the system for which power is supplied including location, population served, track mileage, number and weight of car equipment operated, car mileage, labor conditions, and gross receipts, should be available for reference.

Regular periodic records of all factors entering into the operation of the plant are to be kept under the general headings:

Hourly logs
Power data
Load characteristics
Service on equipment
Equipment unit performance and efficiency
Climatic conditions
Fuel price and quality
Labor wages and time
Other materials, price and quantity
Unit costs data

The time period used should represent a full cycle of operation. Twenty-four hours fulfills this condition where extreme detail is required, but, in general, a one week period better represents the cycle of operation. In many cases, a one month period will be satisfactory. In this case, the aggregate quantities should be reduced to an average day to eliminate the variation in length of month.

Blanks and Forms

Hourly Logs:

Load on generating units and auxiliary units
Power output from station bus
Generating units in service
Boiler units in service
Fuel consumed

Hourly Logs — Continued

Water used for steam
Weather
Temperature
Barometer
Draft
Temperature circulating water
Temperature feed water
Temperature of machine windings
Vacuum in condenser
Power used by auxiliaries
Boiler pressure
Steam temperature
Voltage
Frequency or speed

Power Data (Daily record and monthly summary):

Output of each generator
Generated power used by auxiliaries
Generated power used for other station purposes
Power from outside sources used in operation
Total net output from station bus

Load Characteristics (Daily record and monthly average):

Average load on station
Maximum integral one hour peak load
Maximum momentary peak load
Ratio of one hour peak to average load
Capacity peak load

Service on Equipment (Daily record and monthly summary or average):

Boiler hours in service — active — banked
Number of boilers on peak load — daily
Generator hours in service
Generator hours running no load
Total pounds of water used for steam
K.W.H. output per boiler hour in active service
K.W. per boiler on capacity peak load
K.W.H. output per generator hour in service
Pounds of coal per boiler hour
Pounds of water per boiler hour
Repair logs

Equipment Unit Performance and Efficiency:

Characteristic curves of generators
Characteristic curves of boilers and furnaces
Characteristic curves of pumps
Power consumption data of auxiliaries

Climatic Conditions (Daily record and monthly summary):

Weather — duration of storm periods
Temperature — mean and range
Barometer — mean and range

Climatic Conditions (Daily record and monthly summary) — Continued

Draft
Temperature boiler feed water
Temperature circulating water
Vacuum of condenser — average

Fuel (Quantity—Price—Quality) Monthly Summary:

Pounds of coal used per month
Tons of coal handled per month including storage
Source and condition of coal
Samples of coal
B. t. u. value as received
Per cent of ash as received
Per cent of moisture as received
Cost per ton delivered

Labor (Wages and Time) Daily Record and Monthly Summary:

Handling coal and ashes
Firing boilers
Cleaning boilers
Operating generating units and auxiliaries
Electrical operation, cleaning and maintenance
Building and janitor work
Maintenance boilers
Maintenance furnaces
Maintenance conveyor equipment
Maintenance generating equipment
Maintenance pumps
Maintenance piping

Other Material (Price and Quantity) Monthly Summary:

Brick for furnaces
Stoker repair parts
Boiler tubes
Superheater tubes
Conveyor buckets
Conveyor shafts
Conveyor wheels
Conveyor links
Coal spouts
Lubricating oil

Cost Records

To be compiled from reports furnished by Accounting Department.

Superintendent of Power:

Superintendence — plant engineer and assistants
Engineering — department office employees
Testing — laboratory and plant work, instruments and supplies
Records — clerical work, furnishings and supplies

Power Plant Buildings, Fixtures and Grounds (Maintenance) Labor—Material:
- Grounds
- Main building
- House service apparatus
- Other structures
- Miscellaneous

Power Plant Equipment (Maintenance) Labor—Material:
- Coal handling equipment
- Boilers and furnaces
- Stokers
- Stacks and breechings
- Piping
- Pumps and heaters
- Prime movers
- Generating units
- Auxiliaries
- Exciters, etc.
- Switchboard, cables, etc.
- Miscellaneous — labor, material and tools

Depreciation of Power Plant Buildings and Equipment:

Power Plant Employes (Operating):
- Coal and ash handling
- Boiler room operating
- Generating room operating
- Electrical operating
- Miscellaneous labor

Fuel for Power:
- Cost of fuel on cars at mines or docks
- Cost of transportation and switching
- Miscellaneous expenses
- Ash disposal

Water for Power:

Lubricants for Power:

Miscellaneous Power Plant Supplies and Expenses:

Recommendations

The purpose of this report is to provide a ready means of comparing the performance of one steam power station with another. It is believed the work of the Committee this year will serve as a basis for further investigation and it is hoped that suggestions will be brought out at the Convention with this end in view. The section covering "Subdivision of Accounts" under this subject, is recommended to be submitted to the Accountants' Association for suggestion and approval.

CONSIDERATION OF THE BOILER CODE OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS AND SPECIFICATIONS FOR BOILER TUBES

The copy of the Specifications for Lapwelded and Seamless Boiler Tubes accompanies this report and are recommended for adoption as a Standard.

Your Committee has also given consideration to the Boiler Code as drafted by the A. S. M. E. and recommends that this be further studied by the ensuing Committee early in the year in order that any recommendation to the Committee on Standards may be given ample time for consideration.*

SPECIFICATIONS FOR LAPWELDED AND SEAMLESS BOILER TUBES
(Approved by the Boiler Tube Manufacturers of America, Sept. 25, 1914)
(Recommended for Adoption as a Standard)*

I. Manufacture

PROCESS:

1(a) Lapwelded tubes shall be made of open-hearth steel or knobbled hammered charcoal iron.

1(b) Seamless tubes shall be made of open-hearth steel.

II. Chemical Properties and Tests

CHEMICAL COMPOSITION:

2(a) The steel shall conform to the following requirements as to chemical composition:

Carbon	0.08 — 0.18 per cent.
Manganese	0.30 — 0.50 per cent.
Phcsphorous	not over 0.04 per cent.
Sulphur	not over 0.045 per cent.

2(b) Chemical analyses will not be required for charcoal iron tubes.

CHECK ANALYSES:

3(a) Analyses of two tubes in each lot of 250 (or on total order if less than 250) may be made by the purchaser which shall conform to the requirements specified in Par. 2. Drillings for analyses shall be taken from several points around each tube.

3(b) If the analysis of only one tube does not conform to the requirements specified, analyses of two additional tubes from the same lot shall be made, each of which shall conform to the requirements specified.

III. Physical Properties and Tests

FLANGE TEST:

4(a) A test specimen not less than 4 inches in length shall have a flange turned over at right angles to the body of the tube without showing cracks or flaws. This flange as measured from the outside of the tube shall be ⅜-inch wide.

4(b) In making the flange tests, the flaring tool and die block as shown in Fig. 1, may be used.

* Formally approved by both the Committee on Standards and the Convention.

FLATTENING TESTS:

5. A test specimen 3 in. in length shall stand hammering flat until the inside walls are brought parallel and separated by a distance equal to three (3) times the wall thickness, without showing cracks or flaws. In the case of lapwelded tubes, the test shall be made with the weld at the point of maximum bend.

HYDROSTATIC TESTS:

6. Tubes under 5 in. in diameter shall stand an internal hydrostatic pressure of 1000 lb. per sq. in. and tubes 5 in. in diameter or over, an internal hydrostatic pressure of 800 lb. per sq. in. Lapwelded tubes shall be struck near both ends, while under pressure, with a two-pound hand hammer or the equivalent.

TEST SPECIMENS:

7(a) All test specimens shall be taken from tubes before being cut to finished lengths and shall be smooth on the ends and free from burrs.

7(b) All tests shall be made cold.

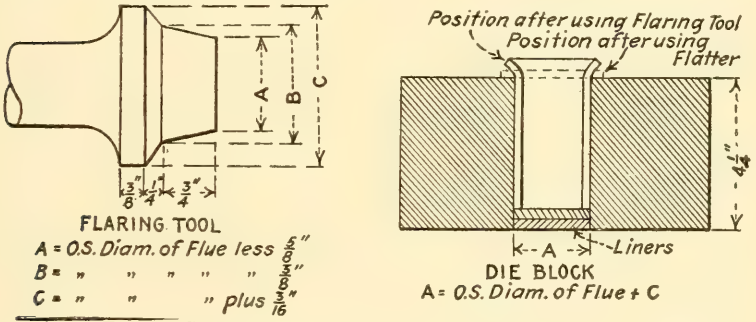


FIG. 1.—DETAIL SKETCH OF FLARING TOOL AND DIE BLOCK, INDICATING CLEARANCES.

NUMBER OF TESTS:

8. One flange and one flattening test shall be made from each of two tubes in each lot of 250 or less. Each tube shall be subjected to the hydrostatic test.

RETESTS:

9. If the results of the physical tests of only one tube from any lot do not conform to the requirements specified in Sections 4 and 5, retests of two additional tubes from the same lot shall be made, each of which shall conform to the requirements specified.

ETCH TESTS FOR CHARCOAL IRON

ETCH TESTS:*

10. A cross section of tube may be turned or ground to a perfectly true surface polished free from dirt or cracks, and etched until the

*A solution of two parts of water, one part concentrated hydrochloric acid, and one part concentrated sulphuric acid is recommended for the etch test.

soft parts are sufficiently dissolved for the iron tube to show a decided ridged surface with the weld very distinct, while a steel tube would show a homogeneous surface.

IV. Workmanship and Finish

WORKMANSHIP:

11. The finished tubes shall be circular within 0.02 in. and the mean outside diameter shall not vary more than 0.015 in. from the size ordered. All tubes shall be carefully gauged with a B. W. G. gauge and shall not be less than the gauge specified, except the tubes on which the standard slot gauge, specified, will go on tightly at the thinnest point, will be accepted. The length shall not be less, but may be 0.125 in. more than that ordered.

FINISH:

12. The finished tubes shall be free from injurious defects and shall have a workmanlike finish and shall be practically free from kinks, bends and buckles.

V. Marking

MARKING:

13. The name or brand of the manufacturer, the material from which it is made, whether steel or charcoal iron, and "Tested at 1000 lb." for tubes under 5 in. in diameter, or "Tested at 800 lb." for tubes 5 in. in diameter or over, shall be legibly stenciled on each tube.

VI. Inspection and Rejection

INSPECTION:

14. All tests and inspection shall be made at the place of manufacture. The manufacturer of boiler tubes shall furnish the purchaser of each lot of tubes a statement of the kind of material of which the tubes are made, and that the tubes have been tested and have met all the requirements of these rules. This statement shall be furnished to the manufacturer using the tubes and shall be forwarded to the local inspectors of the district in which the boiler is to be inspected.

REJECTION:

15. Tubes when inserted in the boiler shall stand expanding and beading without showing cracks or flaws, or opening at the weld. Tubes which fail in this manner will be rejected and the manufacturer shall be notified.

SPECIFICATIONS FOR PURCHASE OF FUEL

The purpose of preparing these specifications was to present the member companies with a typical form of specification and contract as a general guide. In the Appendix are shown typical values of the items in the analysis and an illustration of the application in particular cases.

It is believed that such a typical specification would be of great value if embodied in the *Engineering Manual* under the head of

Miscellaneous Methods and Practices.* No definite action was taken by the Committee on this point and a further study of a typical coal specification may be considered advisable.

Probably the best way to cover the general conditions of specifications to include all grades of fuel will be in the form of blank specifications to be filled in or modified as required by local conditions.

General form of heading:

SPECIFICATIONS AND CONTRACT FOR FURNISHING COAL
FOR
AMERICAN ELECTRIC RAILWAY CO.,
AT
NEW YORK, N. Y.
JULY 1, 1915.

GENERAL:

1. This specification and contract made this ..... day of ..... between (name of Railway or Power Company), a corporation of the State of ....., hereinafter called the Company, party of the first part, and the (name of Coal Company), hereinafter called the Contractor, party of the second part.

WITNESSETH: That the Contractor, being party of the second part, in consideration of the stipulations and agreements hereinafter contained does agree to furnish and deliver (in cars at the mine), (in cars on siding), (on lighters at dock) all coal that may be required for power purposes by the Company for the year beginning ..... and ending ..... in such quantities and at such times and places as may be required by the Company, and the Company, being party of the first part, does agree to purchase and accept same all in accordance with following conditions, (which are hereby made part of this contract).

QUANTITY:

2. The estimated quantity of coal to be furnished during said period, being ....., tons more or less of 2,000 lb. net each (2,240 lb. each),

The Company also has the privilege during the term of this contract to place in storage ..... tons of 2,000 lb. net each (2,240 lb. each) of coal to be used either during the term of this contract, or after the expiration of this contract.

The Company also reserves the right at its option during the year to exempt itself from this contract to the extent of (10%) of the estimated total requirements for the year as stated above for the purpose of making such tests with other coals as they deem necessary or desirable.

DELIVERY:

3. The Contractor shall deliver on the railroad siding at the power plants of the Company (or other place of delivery to be

*See page 450 for action of Committee on Standards.

specified), coal of the quantity and quality herein stipulated, except in case of Floods, Strikes, Acts of God, or other causes beyond his control; and as the Company is a Public Service Corporation it is to have precedence over other contracts for the delivery of coal made by the Contractor.

Coal shall be delivered f. o. b. in (hopper bottom) (flat bottom gondola) cars, which shall not exceed ..... ft. in length over-all or ..... ft. in height from rail to top of car.

Coal shall be delivered in (barges) (self-trimming lighters), which must contain at least ..... tons.

DEMURRAGE:

4. (If contract calls for delivery other than at mines.)

The Contractor shall reimburse the Company for demurrage on shipments of coal due to failure of Contractor to ship in accordance with instructions.

Should demurrage occur on cars of coal delivered by Contractor, the Company reserves the right to withhold the amount of such demurrage, from that month's payments for coal, as may be caused by irregular shipments, bunching of cars, or any other causes for which the Contractor is responsible.

WEIGHING:

5. *Delivery by rail.* The Railroad Company's weights as shown on their expense bills, (or the weights of the Company) will be accepted and bills paid for at said weights. The Company, however, reserves the right to have any or all cars weighed, both loaded and light, and certified to by the Railroad Company delivering the coal at the stations, and to pay for the coal in accordance with those weights instead of accepting the weights shown on the bills of lading of the Railroad Company first receiving the coal at the billing station.

Delivery by boat. The weight of coal recorded by the Company's scales shall be taken as to the amount of coal contained in each lighter, except that when the analysis indicates moisture in excess of four (4) per cent in the coal contained in any lighter, the amount of weight due to the moisture in excess of four (4) per cent shall be deducted from the total weight of the coal, and the net weight taken as the amount of coal contained in such lighter.

NOTICE OF SHIPMENT:

6. (Where coal is received by rail it is usually required that notice of shipment be given. This is not always called for where coal is delivered by boats).

The Contractor shall send to the Company an advance postal notice of all coal consigned under this contract. This notice shall show the billing station, name of the mine from which the coal was originally shipped, date of shipment, and the initials and number of cars. The Contractor shall also furnish the Company with a copy of the Railroad Company's expense bill, showing the car initials and numbers and the weight of the coal.

QUALITY OR KIND OF COAL:

7. The coal furnished under these specifications to be (clean, fresh mined) (kind of coal, name mine or mines), (free from impurities such as slate, stone and dust), a dry sample of which will approximate the Company's standard in heat value and analysis as follows:

Fixed Carbon	——— %
Volatile Matter	——— %
Ash	——— %
Sulphur	——— %
B. t. u.	———

PRICE AND TERMS OF PAYMENT:

8. For and in consideration of the true and faithful performance by the Contractor of each and every covenant and agreement on its part herein contained, the Company hereby undertakes and agrees to pay the Contractor, on or before the (15th) day of each month, the value of the coal delivered during the next preceding calendar month, at the rate of ..... dollars per (long ton of 2,240 lb.) (net ton of 2,000 lb.) f. o. b. (cars) (lighter or barge) (at mines) for standard coal between ..... and ..... B. t. u. both inclusive, as herein specified. All coal accepted shall be subject to all deductions and additions as herein specified for all variations from standard.

Each day's consignment of coal furnished by the Contractor during the continuation of this contract shall be sampled by an authorized agent of the Company, and analyzed to determine its heating value, etc., and the price to be paid by the Company, per ton, per lighter or car of coal will be based on a table of heat values for excess or deficiency of the standard herein contained, but subject to further deductions, for excess ash and sulphur.

The allowances and deductions for variations from the standard, to be added or deducted from the above price, are set forth under "Table of Values and Percentages," and allowance for moisture, when delivered by boat, under "Weighing."

Tests

SAMPLING:

9. *For coal delivered by rail.* A small quantity of coal, approximately one-half (½) a pound per ton of contents, will be taken from different places in each car received, by driving into the coal at different points at five foot ram, before the car is unloaded (Exhibit 1.) These quantities thus taken from each car of coal of the day's consignment will be thrown into a receptacle provided for this purpose.

For coal delivered by barge or lighter. A small quantity or sample of coal, approximately one-half (½) a pound per ton of contents, will be taken automatically from each alternate weighing hopper while the hopper is being dumped during the unloading of the lighter and allowed to drop into a receptacle, provided for this purpose.

Average sample. The contents of the receptacle will be crushed and quartered successively to about ten (10) pounds, and again crushed and quartered down to about two (2) pounds, which after being pulverized in a mill, will be considered as the average sample of the day's consignment or of each barge or lighter. One-half (½) of this average sample, one (1) pound of coal, will be labeled and held for two weeks after the unloading of the cars, barge or lighter. The other half of this average sample will be analyzed as soon as possible after being taken. No other sample will be recognized.

ANALYSIS:

10. An analysis of a dry sample taken from the average sample will be made by the Company's chemist under the supervision of the ....., and a copy of such tests mailed to the Contractor within two (2) days from date that this shipment is unloaded.

Should the Contractor question the results of the Company's test, the Company will, if requested by the Contractor within three (3) days after copy of test has been mailed to him, forward sufficient quantity of the average sample to a reliable laboratory using an (Atwater ..... Bomb Calorimeter) which shall have been previously agreed upon, and have said sample analyzed by it, and the results obtained from this second analysis will be considered as final and conclusive. In case the questioned values as obtained in the Company's analysis shall be found by the second analysis to be two (2) per cent. or less in error, then the cost of said second analysis shall be borne by the Contractor, but if the disputed values shall be found to be more than two (2) per cent. in error, then the cost of second analysis shall be borne by the Company.

Should a second analysis as herein provided for be made of coal taken from any shipment, then any penalties provided for under "Price and Terms of Payment," as set forth in paragraph under "Tables of Values and Percentages" and "Weighing" will be based on the results as obtained from the second analysis.

All analyses will be made in accordance with the standard adopted by the American Chemical Society.

The method of determination of the heat value of the coal will be by the (Atwater ..... Bomb Calorimeter) standardized against a substance of known heat value as obtained from the National Bureau of Standards at Washington.

METHOD OF DETERMINING MOISTURE:

11. A small quantity of coal will be taken from each receptacle provided for under "Sampling," before the coal is crushed and quartered, and about five pounds placed in a jar, which will be sealed immediately thereafter. This small quantity of coal will be the official sample for the purpose of the moisture determination. No other sample will be recognized.

This sample will be held, and a second determination made thereof in the same manner and under the same conditions as is provided for under "Analysis," except that the expense of the second determination will be borne by the Contractor, should there be a variation in the value questioned of ten (10) per cent. or less.

TABLE OF VALUES AND PERCENTAGES:

12. The following allowances and deductions from the price per ton shall apply (made separately) to coal found by analysis to vary from the standard.

B. t. u. Values and Allowances

———	to ———	inclusive,	———c. per ton above standard.
———	to ———	"	———c. per ton above standard.
———	to ———	"	STANDARD.
———	to ———	"	———c. per ton below standard.
———	to ———	"	———c. per ton below standard.

(See Exhibit 2.)

No additional allowance beyond that stated in above table will be allowed for coal having a B. t. u. value above .....

Ash Percentages and Penalties

0	to ———%	inclusive	STANDARD.
———%	to ———%	"	———c. per ton deduction.
———%	to ———%	"	———c. per ton deduction.

(See Exhibit 2.)

No premium will be allowed for coal having a lower percentage of ash than Standard.

Sulphur Percentages and Penalties

0	to ———%	inclusive	STANDARD.
———%	to ———%	"	———c. per ton deduction.
———%	to ———%	"	———c. per ton deduction.

(See Exhibit 2.)

No premium will be allowed for coal having a lower percentage of sulphur than Standard.

DEFAULT:

13. When the Contractor has been notified by the Company to deliver coal under this contract, and failed to comply therewith, a further notice may be given requiring the Contractor to make delivery of the coal so ordered, within twelve (12) hours after the receipt of said second notice. Should the Contractor, for any reason, fail to deliver the coal so ordered within twelve (12) hours after the receipt of said second notice, and in accordance with the requirements therein as to place of delivery, the Company shall be at liberty to buy coal in the open market, and the Contractor shall make good to the Company any difference there may be between the amount paid by the Company for said coal in open market, and the amount the Company would have paid to the Contractor had the coal been delivered by him

in accordance with the requirements of said notices from the Company, and said differences may be deducted from any money then due or thereafter to become due to the Contractor under this contract.

The notices hereinbefore referred to must be delivered in writing, at the office of the Contractor, in the City of ....., and need not be given to any surety.

BOND:

14. The Contractor will be required to furnish a bond of an Incorporated Bonding Company in the sum not exceeding ..... dollars, for the faithful performance of the provisions of this contract, and the discharge of all claims and liens that may be filed against the Contractor, in such manner as to preserve the Company harmless therefrom. The Bonding Company and the form and amount of the bond shall be subject to the approval of the Company.

REJECTION OF BIDS:

15. The Company reserves the right to reject any or all bids or place contract with other than the lowest bidder.

16. This contract and agreement shall bind and inure to the benefit of the successors and assigns of the parties hereto as well as to the parties themselves.

IN WITNESS WHEREOF the parties hereto have hereunto set their hands and seal in duplicate the day and year first mentioned.

(Name of contractor) (Name of company)

by..... by.....

PURCHASE OF POWER STATION LUBRICANTS

(Including Form of Specification)

Perhaps there is no material purchased for power plants that produces a greater variety of specified service demands than the purchase of lubricants. Certain phases are recognized in one and totally omitted in another.

One company for instance in the purchase of lubricants investigated specific gravity, percentage of compounding, free acid, viscosity, flash point, evaporation, smell, price, coefficient of friction and temperature rise with pressure per square inch equivalent to pressure per square inch in the bearing. Tests on machine oils with price varying 50 per cent. may show the same temperature rise and coefficient of friction but one oil, the cheaper grade, emulsifies, the other does not. It has been pointed out also in reference to specifications that it is possible to compound good cylinder oils using a certain percentage per month in conjunction with the cheaper grades and thus producing a lubricant with a flash test of over 500 deg. and a fire test of over 650 deg. The prices paid by the company quoted are cylinder oil 28 cents per gallon, turbine oil 25 cents and engine oil at 13 cents and their acceptance of any oil is contingent on its successful run on a trial.

Another form of specification is even more simple. It simply specifies that the cylinder oil shall have flash enough to overcome the steam temperature where it is intended to be used, also that the viscosity shall vary in cylinder oils from 145 to 170 at 212 deg. Fahr. The question of gravity is left to the discretion of the manufacturers but they point out that the most important point in this oil is to have one in which the petroleum fats have not been destroyed. This of course must be determined by distillation. (Fats do not occur in petroleum oils.) The usual non-emulsifying property of the oil supplied is the last stipulation in this specification. Another specification submitted allows for the use of two distinct cylinder oils both of which give satisfaction, although, it is explained that different engineers on the same system vary in their opinions as to the value of these oils, each preferring their own choice of these separate oils. Both are of dark greenish cast and similar in appearance. Tests on the two give the following:

Oil	A	B
Gravity deg. Baumé	25/26	26
Flash deg. F	275–585	580–585
Burn deg. F	650	650
Viscosity seconds at 212 deg. F	175–185 Saybolt	180–190 Tagliabue
Cold test deg. F	30–35	40

Engine Oil

Dark brown oil giving general satisfaction.

Gravity	29–30
Flash	410–420
Burn	480–490
Viscosity seconds, 100 deg F	230–240
Cold test deg. F	25–30

Turbine Oil

Light oil yellowish in color gives general satisfaction and is a pure mineral oil.

Gravity Baumé	31.5
Flash	400
Burn	450
Viscosity seconds	150 Tagliabue
Cold test	25

Another list of requirements furnished by a member company is as follows:

Lubricating Oils

For example.

600 deg. Steam Refined — Color test green; Gravity test 25.8 deg.; Flash test 540 deg. Fahr.; Fire test 620 deg. Fahr. viscosity seconds. (Tagliabue Viscosimeter) 157 at 212 deg., Fahr. Steam engine cylinders.

Color Test	Gravity test (deg. Baumé)	Flash test (deg. Fahr.)	Fire test (deg. Fahr.)	Viscosity test (deg. Fahr.)
Green	25.8	540	620	157 @ 212 steam engine cylinders.
Straw	25	370	425	163 @ 100 air compressor cylinders.
Lemon	25.1	390	450	198 @ 100 automobile oil.
White	29.6	345	390	94 @ 100 commutators.
Black	22.4	350	410	84 @ 212 cars, switches, conveyors.
Black	24.5	221	302	56 @ 212 conveyors exposed to low temperature.
Red	24.6	385	445	210 @ 100 engines and general machine oil.
Green	23.8	395	495	436 @ 100 car motors.
Green	21.5	485	560	140 @ 212 auto gears.

Another sample specification used by a large member company is briefly as follows, and is used with special reference to their requirements for turbines.

Flash test 280 deg. Fahr. closed.

Fire test 435 deg. Fahr. open.

Viscosity as compared with water.

4.0 at 70 deg. Fahr.
2.5 at 90 deg. Fahr.
1.75 at 120 deg. Fahr.
1.4 at 150 deg. Fahr.
1.25 at 190 deg. Fahr.

Specific gravity 275 equivalent of 30 deg. Baumé (at 60 deg. Fahr.). Oil must contain no acids, soaps or other foreign matter.

Another company has purchased for the same purpose as the above, namely,— Vertical turbines, oil which they specify must be composed of pure filtered neutral oils and must stand 500 deg. Fahr. fire test received from the distillate at the refinery and to run up to 550 deg. Fahr. 29.5 deg. specific gravity Baumé and 400 deg. viscosity but of course the further important factor in connection with horizontal turbines is whether or not the oil emulsifies. In reference to the terms ordinarily used in stipulated requirements or specifications for lubricants the following is submitted as that which is understood to be the meaning of the ordinary terms used.

Recommendation

It was brought out in the discussion that a rigid specification covering the physical and chemical characteristics of lubricants is at the present time inadmissible.

The purpose of this report therefore is to show the results of a number of successful applications of lubricants and to give the characteristic of the oils used. A suggested form of specification has been drawn up along these lines and is appended hereto.

Owing to the absence of complete data on the characteristic of lubricants, it is recommended that this important subject be further studied by the Committee.

SUGGESTED FORM OF SPECIFICATIONS FOR LUBRICANTS

SPECIFICATION FOR FURNISHING LUBRICANTS FOR THE ..... CO.,
POWER HOUSE REQUIREMENTS FOR ..... MONTHS.

The different lubricants to be delivered in suitable drums or barrels distinctly labeled so that there may be no mistake as to the nature of the contents or the purpose for which the specifications designate their use. All vessels used are to be removed when empty at suitable intervals at the discretion of the purchaser or company representative. The material furnished under this contract must be delivered at the place and time as directed by the purchaser.

The right is reserved to extend the time named in this contract for ..... days, proper notice to be given the contractor ..... days before the expiration of this contract. The delivery of the lubricants to commence ..... and be continued until..... When notified of the monthly requirements to be furnished by the contractor and if for any reason there may be a larger or smaller quantity required within a variation of ..... per cent., the delivery shall conform to these requirements upon advice from the proper person representing the purchaser.

Turbine Oil to Stand:

Gravity test, 29 deg. Baumé.
Flash test, 480 deg. Fahr.
Fire test, 520 deg. Fahr.
Cold test, 15 deg. above Zero.
Viscosity test, 200 deg. @ 70 deg. Fahr. Saybolt.

Turbine High Pressure Cylinder Oil to Stand:

Gravity test, 24.5 deg. Baumé.
Flash test, 570 deg. Fahr.
Fire test, 635 deg. Fahr.
Cold test, 30 deg. above Zero.
Viscosity test, 200 deg. @ 212 deg. Fahr.

Turbine Low Pressure Cylinder Oil to Stand:

Gravity test, 25.5 Baumé.
Flash test, 500 deg. Fahr.
Fire test, 560 deg. Fahr.
Cold test, 30 deg. above Zero.
Viscosity test, 160 deg. @ 212 deg. Fahr.

Engine Oil (Pale Colored) to Stand:

Gravity test, 31 deg. Baumé.
Flash test, 410 deg. Fahr.
Fire test, 475 deg. Fahr.
Cold test, 20 deg. above Zero.
Viscosity test, 215 deg. @ 70 deg. Fahr.

Lubricating Graphite Grease

Lubricating grease to consist of about one part of an amorphous graphite pigment of good quality in about two parts of a mixture of mineral grease and a metallic soap pigment. The material must be as free as possible from ash, showing more than 15 per cent. of ash, which must be of a micaceous nature and be free from grit. The material must be so compounded as to soften without flowing at 100 deg. C. It must be free from resin or resinate. It must be equal in lubricating properties to standard sample as determined by practical comparative tests.

Unless otherwise specified, the material is to be delivered in friction-top cans of 25 pounds capacity, properly labeled with the name of the material, the capacity of the can, and the name of the manufacturer.

Mineral Lubrication Grease

COMPOSITION:

Lubricating grease to be a homogeneous mixture consisting exclusively of from 80 to 90 per cent of a mineral oil of specific gravity ranging from 0.885 to 0.903 and the remainder an odorless lime soap made from clean animal fats and the proper amount of lime for saponification. The material to yield not more than 2 per cent. of ash and to be free from fillers, uncombined lime, gritty substances, rosin oil, rosin or resinates, and from mineral or fatty acids, alkalies, or any deleterious impurities.

CONSISTENCY:

The material to flow without separating at a temperature of from 50 to 80 deg. C., and when heated for one hour at 110 deg. C. to lose not more than 2 per cent of its weight.

LUBRICATING PROPERTIES:

To possess lubricating properties determined by practical test in lubricant-testing machine as follows: When fed at the rate of 1½ grains per minute through a grease cup, on friction surface of a brass shoe having 9 sq. in., bearing surface, sustaining a load of 1,926 pounds against a steel journal 6 in. in diameter revolving at a surface velocity of 405 feet per minute, it shall maintain an even temperature of not more than 60 deg. C. above surrounding normal temperatures, and the coefficient of friction shall be constant during the last hour of the run and shall be less than 0.013.

PURPOSE:

Mineral lubricating grease under these specifications is intended for use in compression grease cups for bearings.

Mineral Oil (Kerosene)

Samples of each lot, taken at random, will be tested photometrically after burning one hour in lamps fitted with No. 1 hinge burners, Marcy's patent, the standard employed being a standard Hoefner lamp. After burning five hours longer, the lamps will be again tested to determine any change in the intensity of the light. The flame must be of at least 6 candle-power and must show no material change in intensity during the five-hour interval.

The samples must show a flash test of not less than 115 deg. Fahr. and a fire test of not less than 140 deg. Fahr. The flash and fire tests are to be conducted in a closed tester of the "Tagliabue" type.

The oil will be tested for the presence of free acid. Litmus paper immersed in the oil for five hours must remain unchanged. The specific gravity must not be greater than 0.800 for Eastern oil and not greater than 0.813 for Western oil at a temperature of 60 deg. Fahr., to be purchased and inspected by weight. The oil must burn steadily and clearly, in a standard lamp or lantern, without smoking and with a minimum incrustation of the wick for a period of at least seventy-two hours.

INSPECTION AND DELIVERY

Before acceptance the oil will be inspected. Samples of each lot will be taken at random, the samples well mixed together in a clean vessel, and the sample for test taken from this mixture. Should the mixture be found to contain any impurities or adulterations, the whole delivery of oil it represents will be rejected, and is to be removed by the contractor at his own expense.

The quantity delivered to be determined by weight — the number of pounds per gallon to be determined by the specific gravity of the oil at 60 deg. F. multiplied by 8.33 pounds, the weight of a gallon (231 cubic inches) of distilled water at the same temperature.

DEFINITIONS

Cohesiveness.

The property of the particles of oil to adhere to each other and their ability to withstand the tendency of the metal to cause this disruption.

Adhesiveness.

The property to stick to anything else. Both of these properties must be present. Any deficiency in either of these properties may render any lubricant useless. This also applies to an unequal development.

Viscosity.

Is the harmonious combination of the above properties and this blending determines the value of an oil as a lubricant. Viscosity also refers to the body or fluidity of an oil. Determination is made with an instrument called a Tagliabue Viscosimeter.

Fluidity.

Is the property of the lubricant to flow and this flow is caused by the particles separating and re-adjusting themselves. It is obvious that a correct balancing of these different properties makes up the requirements for the different purposes of lubricants and these adhesive and cohesive properties combined with the right amount of the active discriminating fluidity determines the value of any particular lubricant for any given purpose and that is further determined by the ability of the lubricant to carry pressure in any direction without the metals coming into contact.

Temperature.

That is the ability of the oil to maintain its lubricating properties with the least amount of friction at any given reasonable range of temperature and of necessity this must vary, as one condition may demand an oil to maintain its viscosity at very low temperature. An oil that loses its fluidity under these conditions of low temperature loses its efficiency in proportion to the extent to which the flow is affected or in higher temperature the fluidity may be accelerated to such an extent that the same detrimental effects are in evidence although from diametrically opposite conditions. In determining the selection of a lubricant we may remember oils are divided into two classes, fat or fixed oils and the essential or volatile oils. The fatty oils are derived from animal and vegetable sources and are a mixture of three substances of similar properties, two of them at ordinary temperatures are solid stearine and margerine and the third a fluid oleine. The last is the property that gives fluidity and smoothness to the lubricant. Both kinds of oil, animal and vegetable are composed of carbon, hydrogen, and oxygen in almost equal proportions and the choice for service lies between the two as for instance — an oil that emulsifies is unfitted for turbine use but for cylinder lubrication an oil that emulsifies must be used. On the above lines, the following form of specification is presented: Consideration in view of the foregoing must be given to the following points: Viscosity, Free acid, Flash point, Fire point, emulsifying properties, nature of compounding as mineral and animal fats, price, delivery, time and place, and vessels to be used, evaporation, and deterioration.

THE STANDARDIZATION RULES OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

(Recommended for Consideration by Members)*

The revised Standardization Rules of the American Institute of Electrical Engineers, Edition of December 1, 1914, constitute a work of great benefit to the electrical profession.

The definition of terms, the explanation of methods of tests and the specifications covering the limits of capacity in apparatus are believed to be more thorough and explicit than in any previous rules.

*See page 451 for actcn of Committee on Standards.

The development of the art, however, has necessitated a number of changes and it is the purpose of this report to call the attention of the various member companies to some of the principal new standards.

The most radical changes relate to the question of rating of apparatus, a matter which affects all purchasers of electrical machinery.

Without taking up these rules in detail it is believed that the principal changes should be noted here.

KINDS OF RATING:

There are but three kinds of rating recognized, namely:

"Continuous Rating", "Short-Time Rating" and "Nominal Rating", (Sections 142, 143 and 144). All overload ratings have been omitted. The only exception to this rule is that all Railway Motors and Railway Sub-Station Machinery have certain overload ratings included in their nominal rating.

HEATING AND TEMPERATURE:

The temperature limitation of the capacity of electrical machinery is now based upon that prescribed by the life of the insulating material, therefore the permissible limits for each kind of rating noted above so far as temperature is concerned will necessarily be much higher than heretofore. (Section 149.) These actual temperatures are given later.

The temperature of reference above which the temperature rise is calculated is called the "Ambient Temperature" or the temperature of the surrounding fluid which of course is usually the air. (Section 152.) The standard Ambient Temperature of reference for air is now 40 deg. C. instead of 25 deg. C. as heretofore. (Section 153.) The standard Ambient Temperature for water-cooled machinery is 25 deg. C. for the incoming cooling water. (Section 157.)

The correction for deviation from the standard ambient temperature of 40 deg. is now eliminated, the statement being made that tests show any correction to be of doubtful value. (Section 168.)

METHOD OF TEMPERATURE MEASUREMENTS:

Three methods are considered, namely:

"Thermometer", "Resistance" and "Imbedded Temperature-Detector Method" ("Thermo-Couples or Resistance Coils"). (Sections 174, 177 and 182.)

These three methods are explained and a different correction factor is used with each in making allowance for Hottest-Spot. With the Thermometer Method the Hottest-Spot is assumed to be 15 deg. C. higher than that shown by the Thermometer Reading; with the Resistance Method the Hottest-Spot is assumed to be 10 deg. C. higher, with the Imbedded Detector Method the Hottest-Spot is assumed to be 5 deg. C. higher.

TEMPERATURE LIMITS:

The permissible Hottest-Spot Temperature and corresponding temperature rises for three classes of insulation are prescribed as follows:

Class	Description of material	Hottest spot	Permissible rise above 40 deg. C.
		(degrees C.)	(degrees)
A-1	Cotton, silk or other fibrous material	95	55
A-2	Impregnated fibrous material	105	65
B (Sec. 188)	Mica, asbestos, etc	125	85

The above temperature rises are for the purpose of fixing the Institute's Rating and are subject to the correction mentioned above depending upon the Method of Temperature Measurement.

The actual limiting temperature rises when the Thermometer Method is used are 40 deg. C. for Class A-1 Insulation, 50 deg. C. for Class A-2 Insulation and 70 deg. C. for Class B. Insulation. (Table referring to Section 192.)

SPECIAL CASES OF TEMPERATURE LIMITS:

The Hottest-Spot Temperature referred to above may be exceeded on special parts of apparatus such as squirrel cage winding, collector rings, commutators, etc. (Sections 193 to 200 inclusive.)

Additional requirements which do not affect the rating but which are properly a part of the specifications relate to short-circuit stresses, over-speeds, commutation of overloads, and stalling torque. (Sections 201 to 204 inclusive.)

EFFICIENCY AND LOSSES:

Attention is called to the fact that the "Efficiency" of Electrical machinery as usually stated is the "Conventional Efficiency" which is the ratio of the output to the sum of the output plus the losses or it may be the ratio of the input minus the losses to the input. This is due to the inability of measuring certain losses to which in some cases conventional values are assigned or in some cases they may be given zero values. "Conventional Efficiency" is so used as to be distinguished from "Machine Efficiency" or the ratio of the power delivered to the power received which therefore includes all losses. (Sections 207 to 221 inclusive.)

The actual losses taken into account in various types of machines in which Conventional Efficiencies are generally used are explained in Sections 222 and 227. The approximate value of certain indeterminate losses are explained in Sections 228 to 246 inclusive.

DIELECTRIC TESTS OF MACHINERY:

The method of making such tests and the value and measurement of the test voltages are described in detail in Sections 247 to 276. There

is also given standard insulation resistance values for various voltage and capacity ratings of machines.

REGULATION:

Definitions of Regulation as regards speed, voltage, frequency, power factor and wave form are explained in Sections 279 to 302.

TRANSFORMER CONNECTIONS:

Standard methods of marking leads of transformers are shown in Sections 303 to 312.

INFORMATION ON THE RATING PLATES OF MACHINES:

The exact data to be used on name plates for various types of machines are given in Sections 313 to 320.

STANDARDS FOR WIRES AND CABLES:

It is assumed that the Committee on Distribution will handle this subject.

STANDARDS FOR SWITCHES AND OTHER CIRCUIT CONTROL APPARATUS:

This includes switches, circuit breakers, fuses, lightning arresters, protective reactors, rheostat and instrument transformers, and includes a definition, a basis of rating and the required performance and test for each type of apparatus. (Sections 367 to 387.)

STANDARDS FOR ELECTRIC RAILWAYS:

Definitions are given of the parts of the Electric Transmission System.

The rating of Railway Sub-Station Machinery is put on a nominal basis as follows:

Section 391. The nominal rating of a Sub-Station machine shall be the Kv-a output at a stated power-factor input, which, having produced a constant temperature may be increased 50 per cent for two hours without exceeding the standard ultimate temperature rise. In the case of frequency-changers, the power factor of the output shall also be stated.

Machines in Sub-Stations subjected to extreme fluctuations of load, should be capable of carrying a load of twice their nominal rated load, for a period of five minutes, and should also be capable of carrying a load of three times the nominal rated load for one minute without disqualifying them for continued service. These overloads shall be applied after a continuous run at nominal rated load.

Section 392. The continuous rating of a Sub-Station machine shall be that load at 100 per cent. power factor which it will carry continuously with a temperature rise not exceeding that set forth in Paragraph 188 and fulfilling the other requirements set forth in these Rules and summarized in Paragraph 132.

RAILWAY MOTORS:

It is assumed that the Committee on Equipment will handle this subject.

RECOMMENDATION

Owing to the changes in these Rules and their important bearing on the question of rating of electrical apparatus it was the consensus of opinion that these Rules be recommended to the consideration of the members of the Association.

Respectfully submitted,

R. J. S. PIGOTT,
A. B. STITZER,
E. D. SMITH,
W. H. ROBERTS,
G. H. KELSAY,
E. H. SCOFIELD,
FAY WOODMANSEE,
J. W. WELSH, *Chairman.*
Committee on Power Generation.

APPENDIX A

METHOD OF ANALYSIS OF STEAM POWER STATION COSTS

The principal variable factors influencing the cost of manufacture and for which allowance must be made in order to compare the actual performance of a plant with the standard established for that plant are:

Power demand
Load characteristics
Coördination of equipment to power demand
Equipment unit performance
Fuel used in banked boiler units
Station standby losses (not including fuel for banking)
Fuel heat value and other qualities
Price of fuel
Class of labor
Wages for labor
Miscellaneous costs
Maintenance
Cost of materials and supplies
Climatic conditions

For comparing the standards established for one plant with that of another plant, additional allowances should be made for:

Physical characteristics of the plant
Local general conditions
Efficiency of management
Volume of output
Age and condition of equipment

The variable factors are best illustrated for purpose of study by curve charts, a number of which are shown in the following discussion.

A set of standard charts may be established for any plant either by analysis of the known conditions existing in the plant, by a study of the actual performance of the plant as shown by records extending over a considerable period, or preferably, by a combination of the two sources of information. Such standards may change from time to time as warranted by possible change or improvements in the equipment or operation of the plant. Figures 1 to 6 illustrate such a set of standards calculated for a plant supplying power to a railway system and operating in conjunction with a water power plant of variable capacity. On these charts are shown:

Fig. 1. The typical load curve for the plant, in this case the composite daily load curve of the month.

Fig. 2. The relation of load characteristic to power demand.

Fig. 3. The coördination of equipment units to power demand.
Fig. 4. The generating unit characteristic in relation to power output of the unit.
Fig. 5. The fuel performance of the plant in relation to power output of the plant, and load characteristic (peak ratio).
Fig. 6. The relation of unit costs of various items to peak ratio.

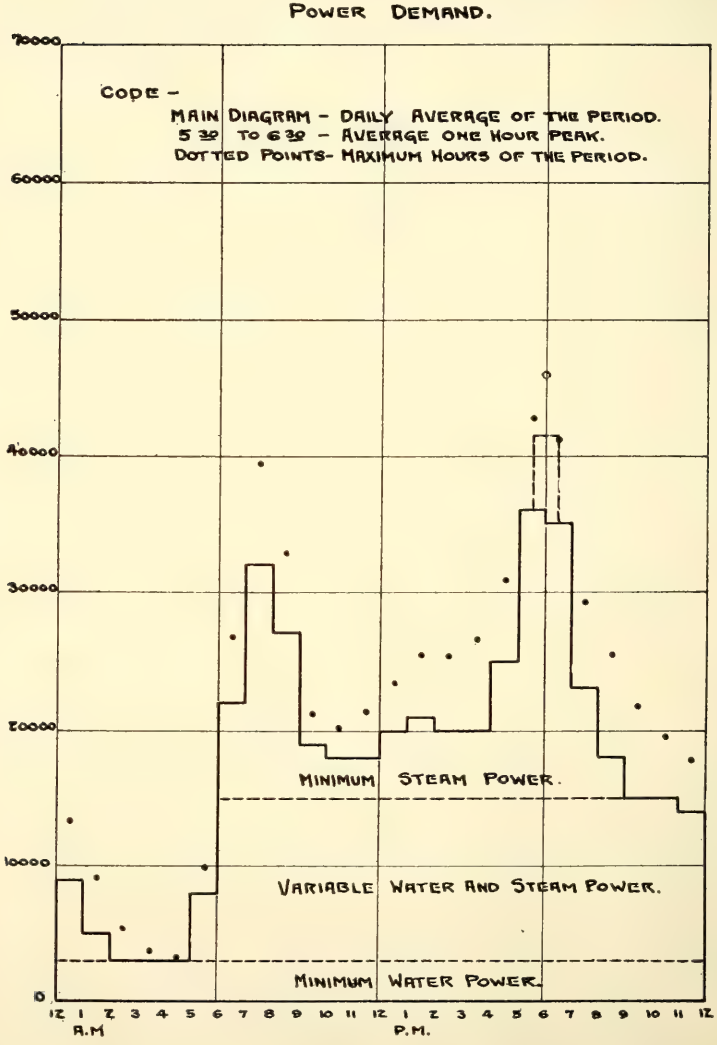

POWER DEMAND.
CODE –
MAIN DIAGRAM – DAILY AVERAGE OF THE PERIOD.
5 ½ TO 6 ½ – AVERAGE ONE HOUR PEAK.
DOTTED POINTS – MAXIMUM HOURS OF THE PERIOD.
70000
60000
50000
40000
30000
20000
10000
0
MINIMUM STEAM POWER.
VARIABLE WATER AND STEAM POWER.
MINIMUM WATER POWER.
12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
A.M
P.M.

FIG. 1.

DISCUSSION OF CHARTS

Fig. 1 shows a complete record, for one period of all required data relating to power demand and load characteristic on a basis of one hour readings. Some plants might require readings of less than one hour period for determining maximum demand or capacity peak.

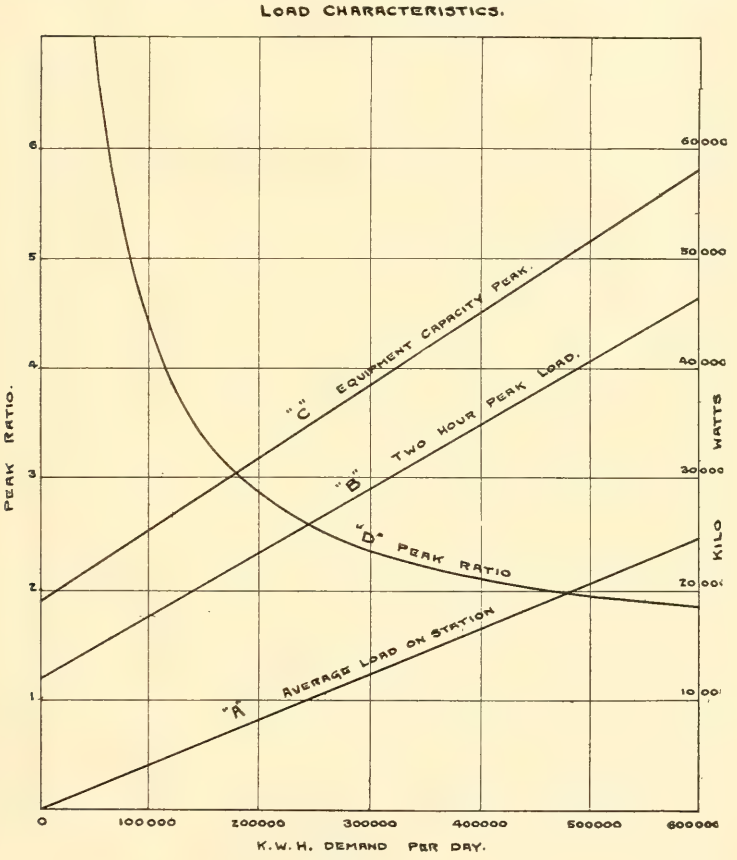


FIG. 2.

The main curve is constructed by averaging all the readings for the same hour during the period. The capacity peak curve is constructed after the same plan, from readings of output taken on the half hour. The dotted points are obtained by selecting the maximum reading during the period for each hour of the day. The complete chart represents the total demand of the system — the amount of water power for the period being deducted from the total power for the same period to obtain the steam power.

Having a series of such charts covering the ordinary range of variable water supply and load demand, Fig. 2 may be constructed.

Fig. 2 may be constructed as noted above or may be constructed directly from the daily records covering a representative period by plotting the various factors of load demand for each day to output

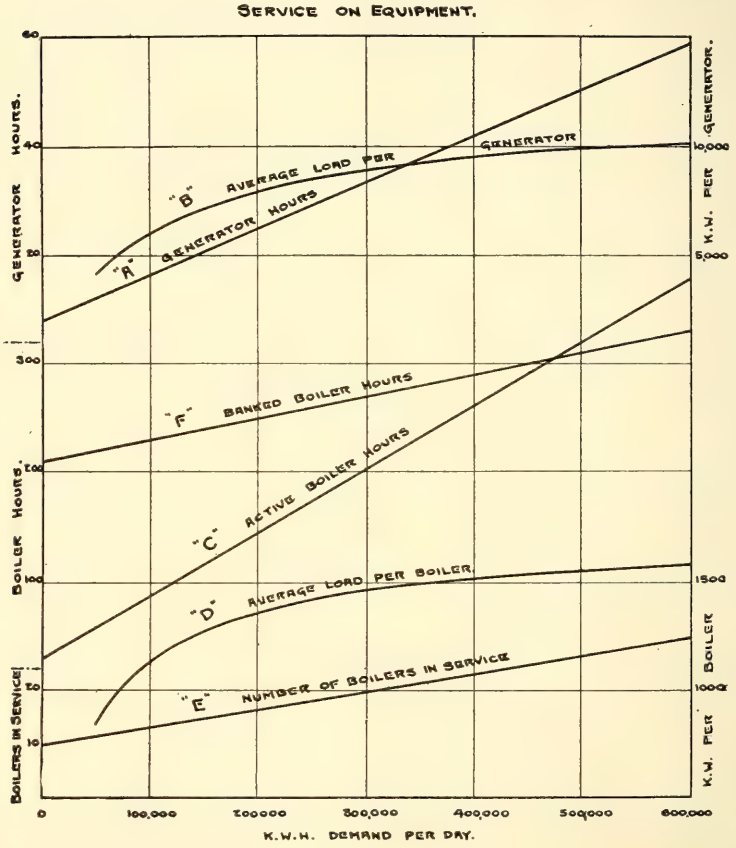


FIG. 3.

of the station for the day. If the latter method is used, the results should be checked by the method outlined above.

Curve "A" is average load for the entire period obtained by dividing the total output by total hours of the period.

Curve "B" is the average of the maximum two hour readings of each day for the entire period, and, is selected as the most representative peak in this particular case for comparing the economic performance.

Curve "C" is maximum one hour load during the period as shown by readings taken by half hour periods during the peak load on the station. This curve determines the capacity of equipment necessary to be kept in commission ready for service at all times during the period.

Curve "D," the ratio obtained by the division of the two hour peak by the average load, is used as the general basis for comparison of the economic results of the plant. It is the reciprocal of the load factor curve and is the more rational basis of the two, as all unit performance curves on this basis are straight line curves having a simple formula, easily analyzed (see Fig. 6).

Fig. 3. The factors entering on this chart are best derived from the actual experience of the plant. They may, however, be arrived at approximately by careful analysis of load demand characteristic and unit capacities. The average unit loads determined on this chart are used for arriving at the average performance and efficiency of the equipment units.

Curve "A" is the total generating unit hours on load for the period, divided by the number of days, and may be determined from the average load characteristic or from actual period of operation.

Curve "B," the average load on the generator units, is determined by dividing power demand by generating unit hours.

Curve "C," the active boiler hours in service, is determined in the same way as curve "A."

Curve "D," the average load on boiler units, is determined by dividing power demand by active boiler hours.

Curve "E," the number of boiler units in service, is determined by dividing the capacity peak by the maximum capacity rating of the boiler unit (in the case under consideration, the capacity rating is taken as 1900 Kw.).

Curve "F," boiler unit hours banked, is determined by deducting the active boiler unit hours from the total service boiler unit hours (number of boilers in service x 24).

Fig. 4. The curves on this chart are derived from the primary unit performance curve as determined by actual runs under test conditions and constant load. The final curves refer to a base coördinate representing average load on the unit covering a definite period. Other curves refer to a base coördinate to the same scale representing a constant load.

Curve "A," the primary curve of this chart is the performance curve of the main generating unit throughout its range of load as determined by tests at constant load in pounds of steam per K. W. H.

Curve "B" is the above performance converted to aggregate amount of steam in pounds per hour. This curve is a straight line throughout its lower range intersecting the origin of the chart at a point above zero, measured by the fixed or constant losses of the unit and having an upward tendency in its upper range on account of steam congestion.

Curve "C" is curve "B" with an amount added equivalent to the amount of power used by all station auxiliaries, and, in this case, is arrived at by adding to curve "B" an amount varying from 5 per cent. of the main units full load steam consumption at full load output, to 3.25 per cent. of the same quantity at no output.

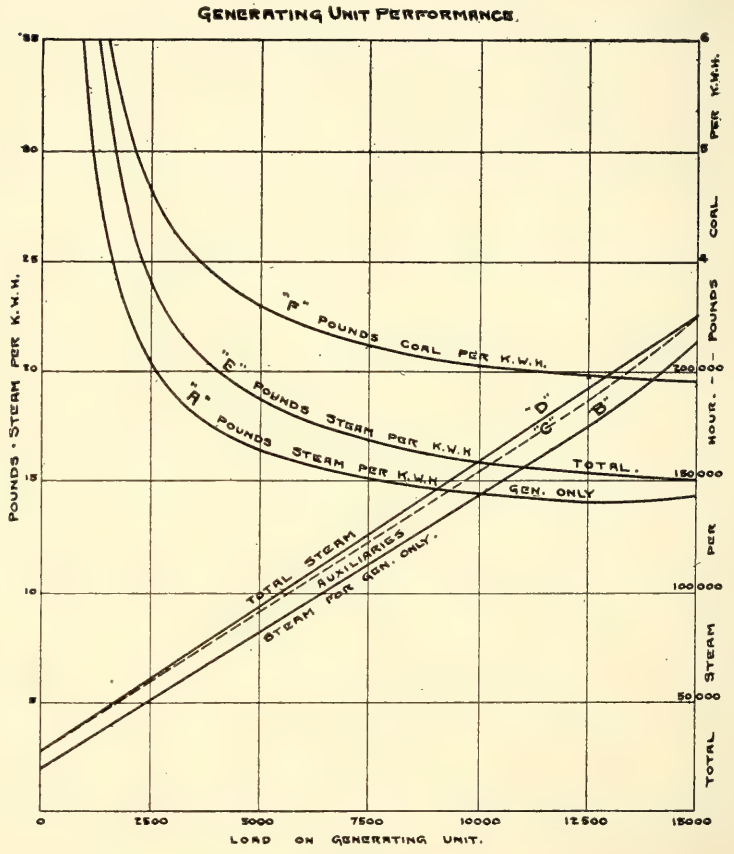


FIG. 4.

Curve "D" is curve "C" corrected for the condition of the average performance of a fluctuating load in place of a constant load. A detail analysis indicated that a straight line joining the ends of curve "C" represented approximately the average performance of a unit operating under a fluctuating variable load. This performance is shown by curve "D."

Curve "E" is curve "D" converted to a rate curve in pounds of steam per kw-hr.

Curve "F," pounds of coal per K. W. H., is derived from curve "E," using a boiler efficiency of 60 per cent and coal value of 10,000 B. t. u. per pound.

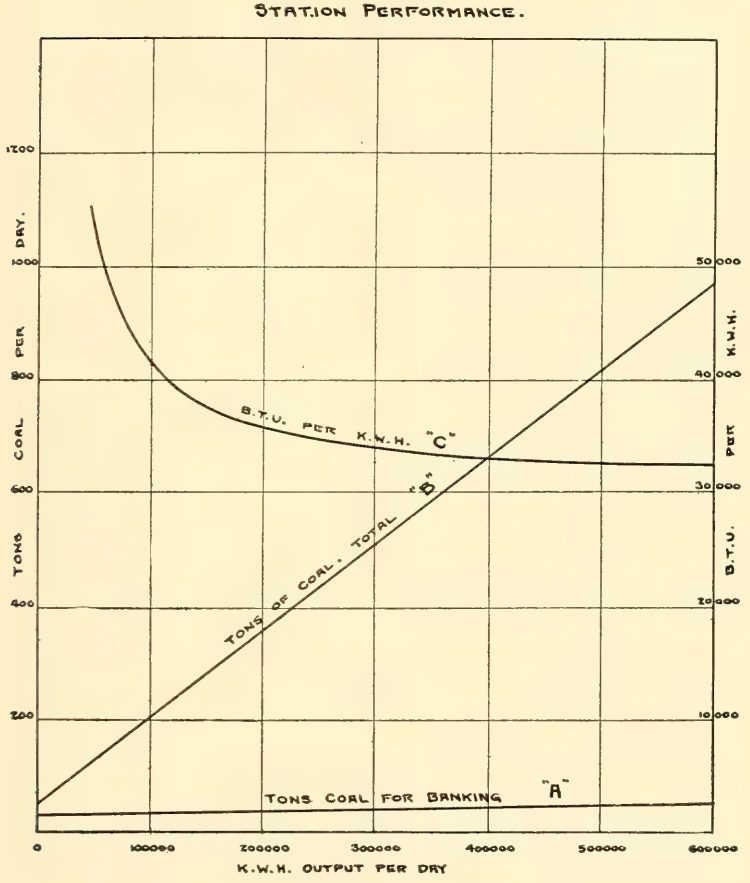


FIG. 5.

Fig. 5. The curves on this chart are derived from the data curves on Figs. 2, 3 and 4, and show the station performance for the conditions outlined by these charts in relation to the power output.

Curve "A," coal used for banking, should be determined by actual observation. The amount will vary, depending upon the type and size or capacity of the furnace; the quality of the coal; the duration of the banking period; and the management of the plant. From various reports and estimates, the amount of 300 lb. of 10,000 B. t. u. coal

per hour for a 550 nominal horse-power boiler when banked from ten to eighteen hours, was arrived at. This multiplied by total banked hours gives the coal for banking.

Curve "B," the total coal consumed, is determined by adding to the curve "A," the amount of coal used for operating the generating units

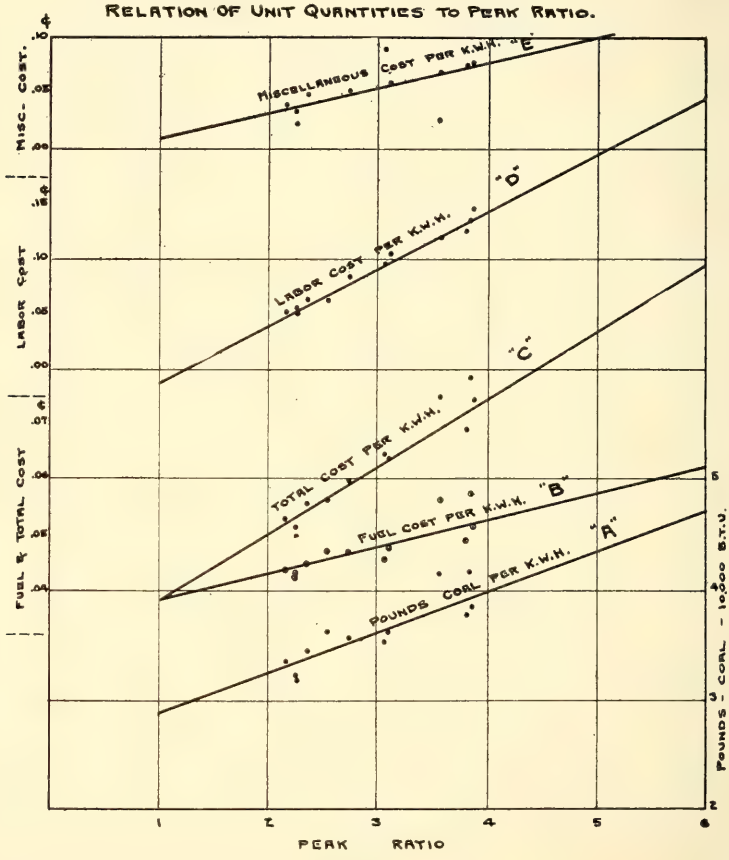

RELATION OF UNIT QUANTITIES TO PEAK RATIO.
MISC. COST.
LABOR COST
FUEL & TOTAL COST
MISCELLANEOUS COST PER K.W.H. "E"
LABOR COST PER K.W.H. "D"
TOTAL COST PER K.W.H. "C"
FUEL COST PER K.W.H. "B"
POUNDS COAL PER K.W.H. "A"
POUNDS - COAL - 10,300 B.T.U.
PEAK RATIO

Fig. 6.

at the average loads shown in Fig. 3. Curves "3-B" and "4-F" are used in making the calculations for this.

Curve "C," B. t. u. per K. W. H., derived from curve "B," is the variable rate curve for change of station output.

Fig. 6 shows the relation of unit performance to peak ratio, when derived from the general operating conditions for any plant, in a form to be used as a standard for purpose of comparing the operating results

of this plant for any period, or for comparison with a similar chart prepared for any other plant.

On the chart is shown the results obtained from a plant for each month's operation covering a period of one year.

Correction Factors

With Reference to Paper by H. G. Stott and W. L. Gorsuch.*

Figure of merit and reduction factor for determining relative value of coals.

Formula:

$$\frac{\text{B. t. u. per ton (moist)} - \left(\frac{2240 \times \%\ \text{ash}}{100} \times \text{B. t. u. per pound of refuse}\right)}{\text{Price per ton (2240 lb.) (\$.)}}$$

Suggested: That a standard B. t. u. per pound of refuse be used in this formula in place of the actual — as this item is a factor of operating efficiency rather than of capacity rating or proportion of ash in coal.

Also suggested: That the effect of B. t. u. in refuse may be considered as directly proportional to the tons of coal burned; that is, making it entirely a factor of operating efficiency. In chain grate operation, it is found that the amount of coal per square foot per hour is practically independent of the heat value or ash content of the coal, that equally good efficiency may be obtained with low grade as with high grade coals of similar character, and that the amount of B. t. u. in the refuse depends upon the extent to which the furnace is crowded or the efficiency of handling. Under this consideration the question of B. t. u. in refuse would not enter into the formula and the figure of merit would be the number of B. t. u. purchased per dollar.

Relation between load factor and costs.

Definition daily load factor in per cent =

$$\frac{\text{Actual net output for day of 24 hours} \times 100}{\text{Net maximum hour load} \times 24}$$

Formula by Stott and Gorsuch.

The relation between load factor and cost of production plus production repairs is that the cost per kw-hr. net output varies approximately as the inverse fourth root of the load factor.

Suggested: That for an extended period the average daily load factor is more representative of the average operating condition in the plant itself than a load factor based on the maximum individual hour of the period.

*From Paper in Proceedings of A. I. E. E. June 1913 entitled "Standardization of Method for comparing Power Costs in Steam Plants."

Suggested: That the peak ratio — defined as the reciprocal load factor be used as the basis of reference for unit performance — the foundation for this suggestion being based on the assumption that the principle of the "Willans line" applies to aggregate quantities in relation to station output, in which case the straight line relation of unit performance to peak ratio is a mathematical deduction.

Theory of the "Willans line" as applied to power station operation. The costs of power may be listed under three general classes, as follows:

I. Costs entirely independent of operation or output — depreciation from obsolescence or inadequacy, deterioration from exposure — engineering and superintendence.

Accounts number 45, 46, *47.1*, *47.2*, *47.4*, *47.5*, 47.7, 47.9, 50.1, *50.2*, *50.3*, 52.1, 52.8, 56.

II. Cost dependent upon the number of hours equipment is in service but not directly influenced by the output.

Friction losses, radiation losses, machinery running without load — fuel for banking boilers — a large part of operation labor, maintenance, lubricants and cleaning — supervision.

Accounts *47.1*, *47.2*, *47.3*, *47.6*, *47.8*, *52.2*, 52.3, 52.4, 52.7, *53*, *54*, 55.

III. Costs directly proportional to output — fuel for power generation and expense incidental to handling fuel — expense in connection with water for steam.

Accounts *47.3*, *47.4*, *47.5*, *47.6*, *47.8*, *50.2*, *50.3*, *52.2*, 52.5, 52.6, *53*, *54*.

The relation of these three classes of costs to output of the station will be for any individual plant:

I. Constant — as shown on a curve sheet with reference to station output on the abcissa, a straight line parallel to the base.

II. Variable in proportion to the service hours of equipment units — in a well operated plant the service hours on the most important units will increase uniformly but at a lesser rate than the increase in output; that is, at higher output of the station, higher capacity and better efficiency is realized from the equipment units. Therefore, this class of costs when plotted on a curve sheet as above shows a straight line divergent from the base as output increases and meeting the ordinate of the origin at some point above zero.

III. Variable in proportion to output — as shown on the curve sheet divergent from the base as output increases and meeting the origin at zero.

NOTE: Italicized Account Numbers relate to accounts included in more than one of the three classes I, II, III.

The sum of these three classes of costs increases uniformly as the output increases but at a lesser rate than rate of increase of output and, as shown on the curve sheet, is a straight line divergent from the base and meeting the ordinate of the origin at some point above zero.

Fig. 7 illustrates these relations.

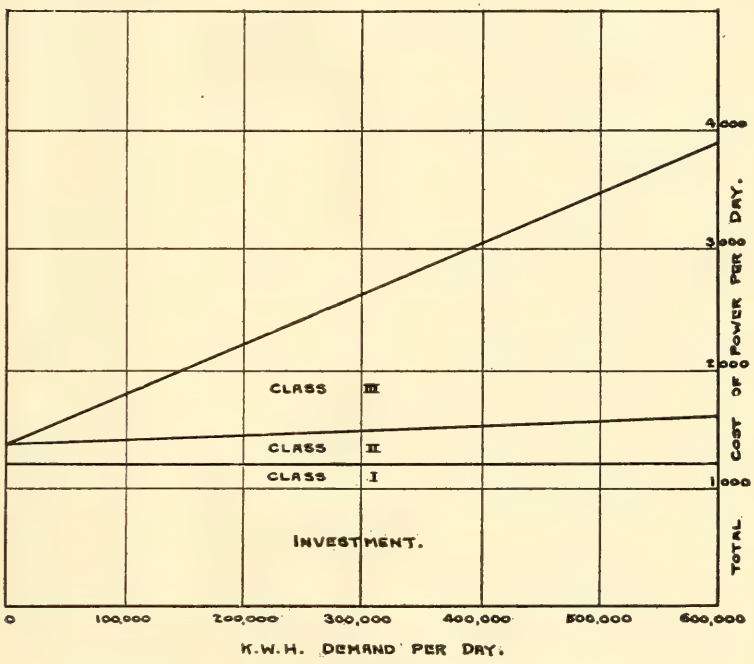


Fig. 7.

APPENDIX B

METHOD OF DETERMINING STANDARD VALUE FOR B. T. U. ASH AND SULPHUR

Purchase from a number of dealers about three (3) days supply of coal for test, specifically stating that all in any one consignment shall be from the same mine. Have samples taken from each car received and analyzed separately or combine the samples from several cars.

Service tests (24 hours) should be made for three (3) consecutive days noting all factors possible, at least the following:

Pounds of coal burned.
Pounds of water evaporated.
Pounds of ash.
Kw-hr. generated.
Kw. demand.
Furnace performance.

The service runs will show the coal best adapted to the furnace conditions, and the analyses of the coal received will show the variations in quality, and furnish values for the standard.

The usual method of sampling coal received by car is by driving a five (5) foot ram into the coal at several different places before unloading car (usually three (3)). The ram is made of two and one-half ($2\frac{1}{2}$) inch pipe with a steel cutter screwed to one end and a knobbed driving head fitting loosely in the other end. The steel cutter (in section) formed like half an arrow head, the outside straight of the same diameter as the pipe, the barb projecting inside forms a contracted ring to hold sample of coal in pipe when withdrawn, and the point or real cutting edge ground to form triangular cutting teeth.

After withdrawing the ram the loose head is removed and the sample of coal dumped into the receptacle provided for this purpose.

The receptacle should be air tight, that is as near so as practical mechanical construction, allowing easy access, will permit.

Several methods of sampling and analyzing are given in the Report of the Committee on Power Generation for 1912, and also in "Notes on the Sampling and Analysis of Coal" published in Technical Paper No. 76, United States Bureau of Mines.

Determination of B. T. U.

The allowable range in B. t. u. for the standard and the increment for allowances and deduction at present in use varies from 50 B. t. u. at 1 cent for a high grade coal to 150 B. t. u. at $1\frac{1}{2}$ cents for a low grade slack coal.

Bulletin No. 41 Bureau of Mines gives the following formula:—

$$\frac{\text{Delivered B. t. u.}}{\text{Standard B. t. u.}} \times \text{Contract Price} = \text{Price to be Paid.}$$

This formula can be expressed in another form and used instead of the table given in paragraph 12, and when the note "Using the integer part only" is added an allowable ranges in B. t. u. of the standard is provided for:—

$$A\left(\frac{\text{Delivered B. t. u.}}{\text{Standard B. t. u.}}-1\right)=B \text{ (Using the integer part only)}$$

A = Cost of coal per ton in cents delivered in front of furnace.
B = Allowance when positive, deduction when negative, in the price per ton in cents.

The range in the standard for coal averaging 12,000 B. t. u. will vary from 240 B. t. u. taking cost at $1.00 per ton to 80 B. t. u. taking cost at $3.00 per ton with B. modified as above, and when limited by "Using the nearest integer value" the above ranges will only be one half or 120 B. t. u. and 40 B. t. u.

But few companies allow a premium for a lower percentage of ash than standard, whereas most companies penalize for an increase, some by gradations of ½ per cent at two (2) cents per ton to 1 per cent at three (3) cents per ton, and some increase the amount of the penalty per gradation for the higher values.

Determination of Ash and Sulphur

The penalty for excess sulphur content varies by gradations of ¼ per cent. at 3 cents per ton to ½ per cent. at 2 cents per ton.

The penalties for ash and sulphur may be expressed in a formula as:—

$$\frac{A-B}{C} \times D=E$$

A = Percent ash or sulphur in delivered coal.
B = Percent ash or sulphur in standard coal.
C = A factor of approximately 50 for ash and 30 for sulphur.
D = Cost of coal per ton in cents delivered in front of furnace.
E = Penalty per ton for excess ash or sulphur in cents per ton.

This may be again limited like the value B for B. t. u. or by "Using the nearest integer value dividable by two (2)".

Some specifications include a penalty for excess Volatile Matter, in one instance this varies by ½ per cent. gradations at 2 cents per ton.

REPORT OF COMMITTEE ON STANDARDS CONCERNING CERTAIN RECOMMENDATIONS OF THE COMMITTEE ON POWER GENERATION

1914–1915

Recommendation of the Committee on Power Generation:

(*a*) As STANDARD: Specification for Lapwelded and Seamless Boiler Tubes as shown on page 418 of this report. That it be adopted as a Standard Specification.

Action of Committee on Standards:

That the Specification for Lapwelded and Seamless Boiler Tubes, as recommended by the Sub-committee of the A. S. M. E. and approved by the boiler tube manufacturers of America on September 25, 1914, be adopted as a **Standard Specification.**

Recommendation of Committee on Power Generation:

(*b*) Boiler Code of A. S. M. E. That it be given further consideration.

Action of Committee on Standards:

Referred back to Committee for further consideration.

Recommendation of Committee on Power Generation:

(*c*) Specification for the Purchase of Fuel as shown on page 421 of this report. That it be embodied in the Engineering Manual under the head of Miscellaneous Methods and Practices, and a further study may be advisable.

Action of Committee on Standards:

Publication in Engineering Manual under Miscellaneous Methods and Practices, approved.

Recommendation of Committee on Power Generation:

(*d*) Specification for Power Station Lubricants as shown on page 429 of this report. At the present time it is impossible to draft a rigid specification covering physical and chemical characteristics of lubricants as suggested form of specification has been drafted to show the results of a number of successful applications and to give characteristics of oils used. It is recommended that this subject be given further study by the ensuing Committee.

Action of Committee on Standards:

That the recommendation of the Committee on Power Generation be approved.

Recommendation of Committee on Power Generation:

(*e*) Analysis of Cost of Power Station Operation. That the Sub-division of Accounts covering Costs be submitted to the Committee on Engineering-Accounting for suggestion and approval, and that the subject be further considered by the ensuing Committee.

Action of Committee on Standards:

That the Recommendation of the Committee on Power Generation be approved.

Recommendation of Committee on Power Generation:

(*f*) Standardization Rules of A. I. E. E. 1–320; 367–387; 390–392. That these rules be recommended to the consideration of the members of the Association.

Action of Committee on Standards:

That this subject be given further consideration in view of the fact that these rules have been further revised by the A. I. E. E. since their consideration by the Committee, the new issue bearing date of July 1, 1915.

Respectfully submitted,

C. F. Bedwell,
W. G. Gove,
E. R. Hill,
A. S. Richey,
J. W. Welsh,
C. S. Kimball,
E. B. Katté,
W. H. Sawyer,
F. R. Phillips,
J. H. Hanna,
C. H. Clark,
Martin Schreiber, *Vice-Chairman,*
H. H. Adams, *Chairman,*
Committee on Standards.

Discussion of Report of Committee on Power Generation

President Crecelius:— The only thing in this report which requires the formal action of the Convention is the approval of the Specification for Lapwelded and Seamless Boiler Tubes, shown on page 418.

This Committee recommends that this Specification be adopted as a Standard.

The action of the Committee on Standards is "That the Specification for Lapwelded and Seamless Boiler Tubes, as recommended by the Subcommittee of the A. S. M. E. and approved by the Boiler Tube Manufacturers of America on September 25, 1914, be adopted as a Standard Specification."

C. R. HARTE:— I move that the recommendation be approved.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the Specification for the Purchase of Fuel as shown on page 421 of this report be embodied in the *Engineering Manual* under the head of Miscellaneous Methods and Practices, and a further study may be advisable.

JOHN LINDALL:— The action of the Committee on Standards is that the publication of this Specification in the *Engineering Manual* under Miscellaneous Methods and Practices is approved.

C. R. HARTE:— I move that the action of the Committee on Standards be approved.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— This leaves the whole report open for discussion.

In regard to this report on power generation the chair desires to call your attention to the fact that in this year's report, for the first time, has been voiced a desire to include as Standard Specifications or Recommendations, matters which seem to be coming pretty generally into use throughout the country. This indicates a very healthy state of affairs, in that we now see for the first time some stability in the art of power production and power plant construction. Heretofore it was the order of the day to make heavy changes, which has caused so much obsolescence in equipment of this character. It is hoped, therefore, that the interesting work of the Committee may be backed up by some discussion in order to get some views on the subject from our western representatives, especially, in view of the fact that they are perhaps not as much interested in steam power plant construction and operation as is the case with the men composing this Committee.

I therefore ask you to participate in the discussion, and to ask questions, or to relate experiences on any points of interest in this report.

E. J. BLAIR:— It seems to me that in this subdivision of power accounts they have gone quite a ways with the subdivision, in other words, I do not quite see the necessity for such a fine subdivision as appears on pages 410, 411, etc. I am of the opinion that if you get to splitting things up too fine sometimes the detail defeats the purpose. For instance, take page 410 at the top where it says: "46. Power Plant Buildings, Fixtures and Grounds (Maintenance-labor-material)." We see in subdivision 3 another heading "House service apparatus" and under this is listed

.31 Elevators,
.32 Lighting,
.33 Heating and ventilating, and
.34 Fire Protection.

Our company has been using simply the heading "House service." I presume it is not compulsory to divide it up in this manner, and I do not see much to be gained by that subdivision. Then again under ".45 Superintendence of Power (Managemen)," under

.4 Records — clerical work, furnishings and supplies which also has the following subdivisions,

.41 Statistics,
.42 Keeping logs and records,
.43 Timekeeping,
.44 Storekeeping,
.45 Miscellaneous office expenses (not under Acct. 85),
.46 Stationery, and
.47 Tellegraph and Telephone (not under Account 89).

That seems to be a great deal of detail. It strikes me that the general heading "Office supplies" is all you need. I simply comment on this, so the Committee may take it under consideration.

C. R. HARTE:— I think it is well to call particular attention to a point referred to by Mr. Blair. In working out classifications of whatever kind it is necessary to "go the limit," to

insure uniformity of practice in the large companies which can wisely use the very minute subdivisions. But it is by no means intended that all companies should so subdivide their accounts; each should use good judgment and stop short of the point where the cost is in excess of the value received by reason of such subdivision. Not only this, but frequently it is desirable to carry certain groups to fine detail while others are wisely kept broad. Just what will be minutely subdivided and what will be lumped is a question to be answered for each case by itself; the important point is to be sure that the divisions and the groups follow the classification.

If a company finds that in its case "House Service Apparatus" is an item too small to be subdivided, it should stop there, including in it the four elements shown and not some other element which does not appear in the classification. It is merely a question of getting corresponding divisions alike.

PRESIDENT CRECELIUS:— Is there any further discussion? We have lots of time for it. Are there any power generation men here in the meeting?

W. H. DAVISON:— I notice in reading the specifications in reference to coal, etc.

On the Pacific Coast practically all of the electric railroads purchase their electric energy from power companies whose plants are operated by water power.

In San Francisco the United Railroads purchase their power from the Sierra & San Francisco Power Company. In Los Angeles the electric lines purchase their power from several water power companies. One of them has a 150,000 volt transmission line. In San Josè electric energy is purchased from the Pacific Gas & Electric Company. Practically the only fuel used by their local plant, is lamp black, which is obtained from their gas works.

W. P. JACKSON:— I am not a power man, but I would like to ask if there is any known relation between a standard heat unit, as applied to coal as compared with oil? Is there any member present who has made such a comparison? We burn oil out here exclusively, and I am always at a loss in not having some way of comparing oil in gallons and barrels to coal in tons.

PRESIDENT CRECELIUS:— Can any gentlemen answer that question?

C. R. HARTE:— I think it would be a question, first, of how you want it compared, whether pound for pound, or gallon against pound. There are tables of carefully determined values of the B. t. u. per pound of all the better known coals, and there are, I know, analyses of at least some of the oils giving the B. t. u. per gallon or per pound, which would enable you then to make the necessary calculation. What these values are, I do not pretend to remember — I am not a power man myself — but such figures exist, and with them will probably be found such other data as will permit the necessary conversions if the figures are not directly comparable with those for coal. I should imagine that some of your technical colleges here on the Coast would have just the information you want.

L. W. STOCKER:— I think the gentleman will find all the information he wants on that subject in great detail in the published reports of investigating bureaus of the U. S. Navy, to be obtained from the Navy Department in Washington.

B. J. DENMAN:— I would also suggest that the information can be found in handbooks, and particularly in the catalogs of some of the boiler manufacturers — the Babcock & Wilcox Company has a catalog which gives the heating value of the various fuels. Just as a matter of comparison, I will say that it is my understanding that the crude oils obtained in this state run about 19,200 B. t. u. per pound. Of course, coal will vary, from 14,500 B. t. u. in the case of the gas coals of West Virginia; as you get into Ohio they will drop down to 12,000 B. t. u. and as you get into Illinois, the northern coals in Illinois will run about 9,500 B. t. u.; the Central Illinois coals about 11,000 B. t. u.; and in the case of coals in Southern Illinois, about 12,000 B. t. u.; and then when you get into Iowa they drop down to 8,500 B. t. u. It is impossible to make a reliable comparison, unless you have specific coals, and even specific mines in the same district.

Whether there is such a wide variation in crude oils, I am unable to say. If you want a unit on which to compare the

operation of various plants, I suggest that the unit be the B. t. u. per kw-hr.; in fact, pounds of coal per kilowatt hour are not a criterion, as you are liable to have changes occur in the character of the coal. If you compare your operating results on the basis of B. t. u. per kw-hr., then you have a unit which will take all the elements into account.

E. J. BLAIR:— I am very much interested in this discussion on the comparison between coal and oil and am sorry that a lot of these Pacific Coast men are not here, as we would undoubtedly gain a good deal of information in listening to them discuss this subject. We have a peculiar situation in our plant, for we run a steam plant with part oil furnace and part coal furnace, and that may seem strange in a city so far east as Chicago, but it is true.

The situation with us for years was that in this particular plant, which is in the downtown district of Chicago, we burned oil, for there were no good facilities for coal handling.

I have been struggling with the problem for some time, and I find that I know very little about the heating value of the oil, and all I have been able to do so far is to find out about how many kilowatt hours I get out of a gallon of oil and compare that in the same boiler room with the pounds of coal per kilowatt hour. All the oil is bought without specification, as we do not know enough about it to draw a specification.

I am trying a system now of keeping the fires up in the coal furnace throughout the average load, and taking the peaks off with the oil furnaces, and you can appreciate that that has some advantages over banking coal fires. As I said before, we burned oil for years, until the oil company raised the price — in fact, doubled it — and then we put in some coal handling apparatus, and now we are trying both, and all I have done so far is simply to find out how many kilowatt hours I obtained per gallon of oil and compared that with the coal.

C. R. HARTE:— I think it might be well to say just another word in regard to burning oil. I am not familiar with the latest developments, but some years ago it was found that there was a marked difference with the same oil, depending

on the various methods used, whether the oil was delivered with a steam jet or an air jet, or what method was employed. In using any figures, in order to get a proper comparison, it would be necessary to have them corrected to the same basis.

PRESIDENT CRECELIUS:— If the chairman may waive the formality of the Chair,— I would like to participate somewhat in the discussion of this report personally.

In regard to the questions raised in reference to the detail of the tentative schedule of power plant accounts presented in this report, it might interest you to know that the necessity for this schedule arose in several localities practically simultaneously, as there are no two railroad companies or power companies which keep, as far as we have been able to discover, the same subdivision of detailed accounts in regard to their operation and maintenance costs.

About two years ago the Committee on Prime Movers of the American Institute of Electrical Engineers, with which Mr. H. G. Stott, of the Interborough Rapid Transit Company, and his associate, Mr. W. S. Gorsuch, were connected, presented a tentative arrangement of power costs very much more comprehensive than our Committee has felt that there was any need for in the present case. For instance, they included in the Institute schedules details for overhead expenses, which brought out a great deal of adverse criticism and the report of that Committee, therefore, was not adopted.

That, however, has paved the way for at least one very valuable feature, namely, to put plants on a comparative basis with reference to such variables as the character or calorific value of the fuel, the differences in the costs of labor and supplies, and appended to this report will be found copies of some of the sections of their report.

It is very necessary for us to have, in order to operate our power plants intelligently, and to give our executives a proper perspective upon our work, a statement which may be easily and readily compared with a similar statement from a similarly situated company. In order to do this, I have found, personally, that it has been necessary to completely revise our arrangement of accounts in order to agree with the arrangement of the accounts of other companies.

To my knowledge the accounts of the Glasgow Corporation Tramways, as presented in the annual report of their general manager, is a very good one, although it is insufficient in detail for our purposes. The Committee felt, therefore, that in order to introduce the subject properly before the Association, it would be well for them to include the general scheme proposed, with a view of drawing out discussion to help next year's Joint Committee on Engineering-Accounting, before which committee the subject will be continued.

In regard to the gentleman's question, as to a basis of determining the calorific value of oil, to reconcile it with coal, I think that is a very opportune one. It is certainly a new question, and has found us all, in almost every case, not prepared to answer. The same situation holds good with respect to the use of gas, where the basis is the cubic foot. As I remember my physics, it is very easy to secure a proper unit of comparison between a gas and a liquid or a solid. All that is necessary to secure this data is simply to refer to proper tables.

I think the Association is fortunate in getting a Standard Specification for Boiler Tubes. I have had occasion to refer to the files of our secretary and have been surprised at the number of requests that are made for information of this character by the member companies upon the Association. The Committee's work upon this subject, therefore, is exactly in line with the policy which has been gradually shaping itself in the direction of standardizing methods, practices, devices and later on, we hope, construction.

Mr. Secretary, have we anything else on our program for this afternoon?

Acting Secretary Stocks:— I have a communication from Mr. E. H. Scofield, a member of this Committee, that bears on the report, which is as follows:

E. H. Scofield (Written Discussion):— The underlying purpose of this report is to arouse an interest, among those who are responsible for the operation of power plants, in improving the performance of such plants.

In order to accomplish such improvement, it is necessary:

1. To have exact knowledge of all conditions and details of operation.
2. To devise a simple and logical method for comparing the various items of performance.
3. To make proper allowance for varying conditions in the same as between different plants.
4. To establish a standard for various items of performance by which the operating force may be governed in the daily operation of the plant.
5. To point out where to direct effort to improve plant operation.

It is realized by the Committee that the present report is but little more than an outline of the subject and is incomplete and unfinished in form. Considerable hard work will be required to put the plan into such working form that it may be adopted and put into operation at the various plants.

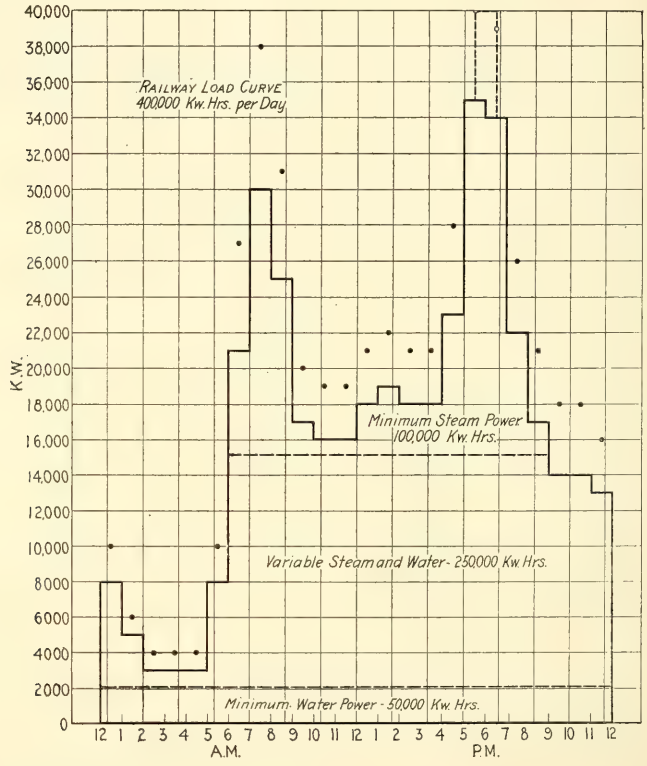
The section relating to subdivision of accounts should be worked out between the Engineering and Accounting Departments of the various companies.

A uniform system of general forms for keeping engineering, operating and cost data should be worked up by a committee of engineers.

A most important phase of the subject is the method of study and analysis of records. This, it is believed, can best be worked out by the selection of five or six representative plants where the conditions of load, equipment and operation are favorable and the management particularly interested, and arrangements made by which data and information may be interchanged. From this accumulation of matter, it will then be possible to formulate certain general laws and relations between the various items of performance which may be used as a guide in outlining a general plan of analysis.

An arrangement of this kind put into effect for one year would undoubtedly produce some very interesting results, which could be submitted in a future report to this Association.

In illustration of this plan, I wish to submit such a study of the conditions in the plant of the Minneapolis Street Railway Company. This study is based on such records as are available in any well managed plant. The conditions in this particular plant are especially favorable for such a study on account of the wide variation of load demand at various seasons.



Illustrating the comparison of the individual monthly performance with an established standard performance for the plant.

General Conditions of Load Demand:

Two hour maximum peak — 34,500 kw-hr.

One hour maximum peak — 40,000 kw-hr.

Aggregate power demand — 400,000 kw-hr. per day.

Water power variable from 50,000 to 300,000 kw-hr. per day.

Steam power variable from 350,000 to 100,000 kw-hr. per day.

Water power supply constant for considerable period.

Daily variation of load supplied by steam power.

Periodic variation of water power replaced by steam power.

Condition of Steam Power Output:

Maximum one hour peak for one day varies from 28,000 to 43,000 kw.

Average one hour peak for one month varies from 22,000 to 37,000 kw.

Average two hour peak for one month varies from 17,000 to 32,000 kw.

Peak excess (above average for 24 hours) varies from 13,000 to 18,000 kw.

Peak ratio 4–2.

Condition of Service on Steam Power Equipment:

Generator hours 10–40.

Active boiler hours 84–230.

Banked boiler hours 220–280.

Number of boilers on load 14–22.

Relation of Steam Performance to Output:

Fuel cost, $170 per day + 0.38c. per kw-hr.

Operating cost, $400 per day + 0.04c. per kw-hr.

Fuel amount, 62.5 tons per day + 29,400 B. t. u. per kw-hr.

Unit Loading in Per Cent of Maximum Output:

Generating units vary from 62 to 39 per cent.

Boiler units vary from 79 to 61 per cent.

Unit Performance of Steam Power Output:

With peak ratios varying from 4 to 2:

Labor cost per kw-hr. varies from 0.05c. to 0.15c.

Fuel cost per kw-hr. varies from 0.41c. to 0.54c.

Total cost per kw-hr. varies from 0.49c. to 0.76c.

B. t. u. per kw-hr. varies from 32,000 to 40,500.

Number of Boilers in Service
20 BOILERS
15 "
10 "
Banked Boiler Hours
250 BOILER HRS.
200 " "
150 " "
100 " "
Active Boiler Hours
30 GEN. HRS.
20 " "
Generator Hours
1000000 POUNDS COAL
750000 " "
500000 " "
Total Pounds Coal
$ 1,500 COST
1000 " "
500 " "
Total Cost
Cost of Coal
40000 K.W.
30000 K.W.
20000 K.W.
Max. One Hour Peak
Average One Hour Peak
Average Two Hour Peak
10000 K.W.
24 Hour Average Load
1915
1914
100000
200,000
300000
400000
KILOWATT HOURS PER DAY

100 PER CENT
Load Per Cent of Rating-Boilers
Load Per Cent of Rating-Generators
42500 BTU PER KW.H.
40000 " " "
37500 " " "
35000 " " "
32500 " " "
30000 " " "
Btu per Kilowatt Hour
0.7 CT. PER KW.H.
0.6 " "
0.5 " "
0.2 " "
0.1 " "
Total Cost
Fuel Cost
Labor Cost
Other Costs
PEAK RATIO
1915
1914

ACTING SECRETARY STOCKS:— That covers everything we have.

PRESIDENT CRECELIUS:— We have gone through our program very speedily this afternoon. Of course, we do not want to pass this report without receiving the same, and a motion to do so is in order.

C. R. HARTE:— I move that the report be received and approved and the Committee thanked for its admirable work.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— We have a very important program for our session to-morrow afternoon, and the Chair would like very much to have a full attendance of the delegates at that meeting. We would like you to make an effort to secure the attendance of those who may be interested in our session.

There being no further business the meeting stands adjourned.

THURSDAY SESSION

OCTOBER 7, 1915

President Crecelius called the meeting to order at 2.15 P. M.

PRESIDENT CRECELIUS:— The meeting will commence today with the Report of the Committee on Way Matters, Mr. C. S. Kimball, Chairman, and in his absence the report will be presented by Mr. C. H. Clark, a member of that committee. If there is no objection, a somewhat different plan with regard to the consideration of this report will be followed, for instead of passing on the recommendations of the committee first, we will have the discussion on the report first and then take up the recommendations later.

REPORT OF THE COMMITTEE ON WAY MATTERS

To the American Electric Railway Engineering Association:

GENTLEMEN.— Your Committee on Way Matters was assigned the following subjects for investigation and report for this year:

Subject (*a*). Consider further the Proper Foundation for Tracks in Paved Streets.

Subject (*b*). Pavement for Use in connection with Girder and High T-rails. Should secure traffic counts from different companies in accordance with forms submitted in 1914 report.

Subject (*c*). Specification with definitions for Sundry Track Materials such as Ties, Track Spikes, Bolts, Tie Rods, Tie Plates, etc., with particular reference to physical characteristics.

Subject (*d*). Specifications for Special Work.

Subject (*e*). Revision of Recommended Designs of Seven and Nine Inch Joint Plates with special reference to sizes of bolt holes and fits. (See Engineering Manual Wm 4a).

Subject (*f*). Review all existing Standards and Recommendations originating with Committee on Way Matters.

MEETINGS

The Committee held its first meeting in two sessions, on January 19 and 20, 1915, at the Association Headquarters in New York City. On January 19th the following were present: Messrs. H. F. Merker,

E. H. Berry, E. P. Roundey, C. W. Gennet, Jr., E. M. Haas, L. A. Mitchell, R. C. Cram, *Vice-Chairman* and C. S. Kimball, *Chairman.*

It was decided to take up and discuss the various subjects in their order of assignment and the Chairman appointed the following Committees:

For Subject (*a*): Mr. R. C. Cram, *Chairman,* and Messrs. E. M. Haas, E. H. Berry and L. A. Mitchell.

For Subject (*b*): Mr. W. F. Graves, *Chairman,* and Messrs. E. H. Berry and L. A. Mitchell.

For Subject (*c*): Mr. C. W. Gennet, Jr., *Chairman,* and Messrs. E. M. Haas and E. P. Roundey.

For Subject (*d*): Mr. E. P. Roundey, *Chairman,* and Messrs. H. F. Merker, C. S. Kimball and W. F. Graves.

For Subject (*e*): Mr. H. F. Merker, *Chairman,* and Messrs. C. W. Gennet, Jr. and R. C. Cram.

For Subject (*f*): This to be considered by the whole Committee at its various meetings.

The remainder of the session was consumed in a general discussion, the most important being that of Specifications for Special Work and it was decided that the Manufacturers of the American Electric Railway Association be asked to coöperate in the preparation of the report on this subject.

After discussing Subject (*e*), the Committee adjourned at 5:45 p. m.

On January 20th the following members were present: Messrs. H. F. Merker, E. H. Berry, E. P. Roundey, E. M. Haas, L. A. Mitchell, R. C. Cram, *Vice-Chairman* and C. S. Kimball, *Chairman.*

At this meeting the remaining subject, that of Reviewing all existing Standards and Recommendations originating with the Committee on Way Matters was carefully considered and our conclusions are included in the body of this report.

At 2:30 p m. the Committee inspected a number of experimental samples of pavement both in the track space and in the roadways of Second Avenue between Houston and 20th Streets, New York.

Your Committee held its second meeting of three sessions at the Sherman Hotel, Chicago, Ill. on June 11 and 12, 1915.

On June 11 the following members were present: Messrs. H. F. Merker, W. F. Graves, E. P. Roundey, C. W. Gennet, Jr., E. M. Haas, L. A. Mitchell, R. C. Cram, *Vice-Chairman* and C. S. Kimball, *Chairman.*

The Co-Chairmen of the various Sub-committees presented their reports, which were discussed and put in form as submitted with this report, with the exception of that covering Specifications for Special Work which was deferred until the session of the 12th so that the Manufacturers' Association could be represented.

An evening session was held on June 11th in order to insure the completion of the report on the 12th.

On June 12 the following members were present: Messrs. H. F. Merker, W. F. Graves, E. M. Haas, E. H. Berry, L. A. Mitchell, E. P. Roundey, C. W. Gennett, Jr., R. C. Cram, *Vice-Chairman* and C. S. Kimball, *Chairman.*

The entire meeting on this day was devoted to the preparation and discussion of Specifications for Special Work.

PROPER FOUNDATION FOR TRACKS IN PAVED STREETS

The following brief reference is made to previous consideration of the subject, as a matter of record.

First considered in a paper on "Ballast" by C. H. Clark, read before the American Street and Interurban Railway Engineering Association in 1906. (Volume 1, page 65 of Proceedings.)

First assigned as a subject for the Committee on Way Matters in 1912 under heading "Proper Ballast for Tracks in Paved Streets." No report. Committee recommended continuance of subject.

Subject assigned to 1913 Committee in its present form. No report. Continuance of subject recommended.

The 1914 Committee gave the subject careful consideration and rendered an extended report (Proceedings 1914 — pages 468, 488, 503, and 509), which included appendices on characteristics of track construction in North America, Bibliography, Foreign Street Railway Construction and Definitions. The report closed with eleven conclusions reached in considering the subject and a Recommendation submitting four types of foundation construction for adoption as Recommended Designs (Proceedings 1914 — pages 484–488).

The Committee on Standards did not approve all of the Designs thus submitted and recommended that the Designs be referred back to the Committee on Way Matters for further consideration, as some of the Designs, in their opinion did not represent the best modern practice. (1914 Proceedings, page 510.)

The discussion in Convention was indicative of the importance of the subject (Proceedings 1914, pages 510–537) and the Convention referred the subject back to the ensuing Committee.

The Committee is pleased to learn that the 1914 Report has proved to be of value to several Member Companies, which have had the subject under discussion with civic authorities.

The Committee this year has been guided in the further consideration of the subject, by the discussion had at the 1914 Convention, and has communicated with a number of engineers asking their opinion on the four types of foundation construction, as submitted in last year's report. A number of replies have been received and the information therein contained has been of material assistance in preparing this report.

It is thought that these opinions confirm the 1914 report as to the predominant use and preference of Type "B", which is plain ballasted

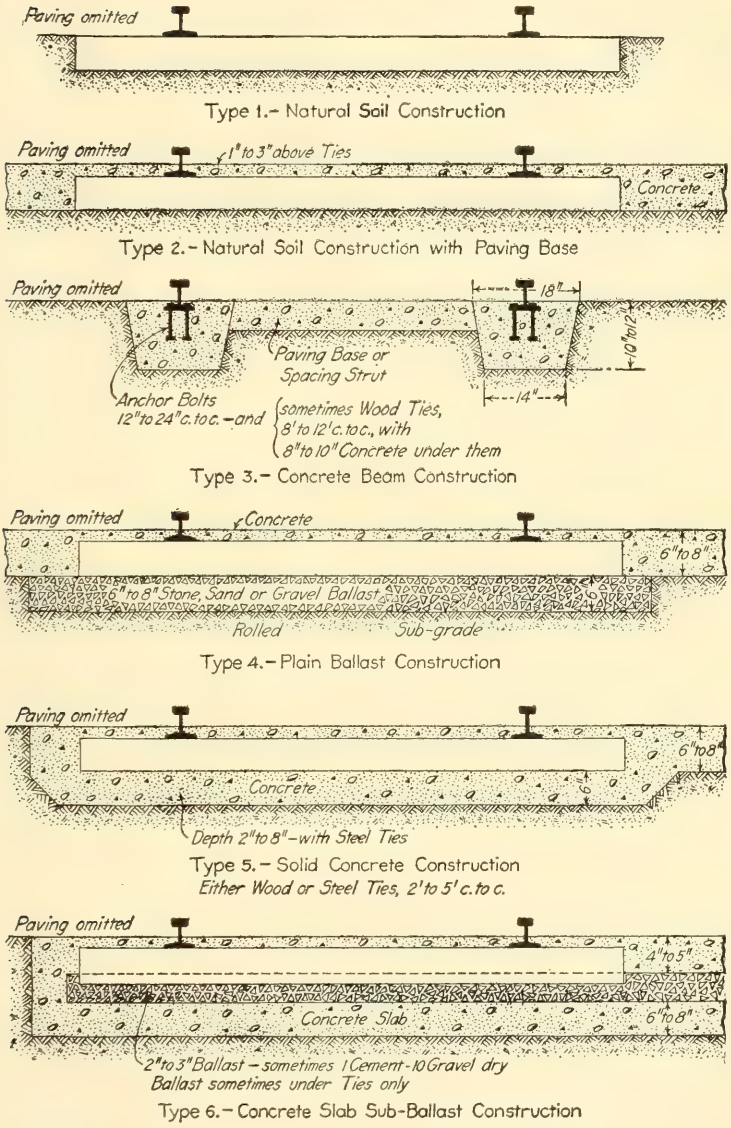

Paving omitted
Type 1.- Natural Soil Construction
Paving omitted
1" to 3" above Ties
Concrete
Type 2.- Natural Soil Construction with Paving Base
Paving omitted
18"
10" to 12"
Paving Base or Spacing Strut
14"
Anchor Bolts 12" to 24" c. to c. - and
sometimes Wood Ties, 8' to 12' c. to c., with 8" to 10" Concrete under them
Type 3.- Concrete Beam Construction
Paving omitted
Concrete
6" to 8"
6" to 8" Stone, Sand or Gravel Ballast
Rolled
Sub-grade
Type 4.- Plain Ballast Construction
Paving omitted
6" to 8"
Concrete
Depth 2" to 8" - with Steel Ties
Type 5.- Solid Concrete Construction
Either Wood or Steel Ties, 2' to 5' c. to c.
Paving omitted
4" to 5"
Concrete Slab
6" to 8"
2" to 3" Ballast - sometimes 1 Cement - 10 Gravel dry
Ballast sometimes under Ties only
Type 6.- Concrete Slab Sub-Ballast Construction

FIG. 1. SHOWING DIFFERENT TYPES OF TRACK CONSTRUCTION.

construction for the most prevalent conditions of soil. The preferences in Data Sheet Information, were given in the 1914 Proceedings, page 479, as follows:

Ballasted construction	60%
Solid concrete construction	33%
Concrete slab sub-ballast construction	7%

On page 478, 1914 Proceedings, it was stated that the data sheets indicated that only 20 per cent of the roads reporting used concrete ballast construction, and it was further stated that a mileage basis for this data would be more indicative of the correct ratios. Confirmation of this data seems to have been secured on a mileage basis as well, in a compilation on the subject gathered in January 1915, by the United Railways and Electric Company of Baltimore, Md., covering some 41 cities, nearly all having over 100,000 population and representing a total of 7330.6 miles of single track. An analysis of the Baltimore statistics gives the following percentages on a mileage basis for types of construction shown in 1914 Proceedings, page 478 and herewith reproduced.

Type 2	23%	1718.1	miles.
Type 3	2%	142.5	"
Type 4	47%	3415.9	"
Type 5	21%	1531.4	"
Type 6	3%	253.9	"
Modification types 3 and 4	4%	278.8	"

(NOTE: The Baltimore type numbers do not correspond with type numbers above, and the information is here transposed to suit Committee type numbers, as indicated in Fig. 1. Page 467.)

If Types 5 and 6 are combined as concrete ballast construction, they give a total of 24 per cent (1785.3 miles) of the total mileage (7330.6) covered by the Baltimore report. This practically substantiates the Committee's statement that only 20 per cent of the roads reporting in last year's Data Sheets use concrete ballast construction. A further analysis of the Baltimore report also tends to substantiate the Committee's statement of Data Sheet preferences as to Types of Foundation as follows:—

Plain ballasted construction	62%
Solid concrete construction	21%
Concrete slab sub-ballast construction	5%

It will be noted that the Baltimore data shows even a lesser percentage of preference for each form of concrete ballast construction and it is thought that the later information probably more clearly indicates the general opinion of way engineers and that this is due to a clearer understanding of the types discussed, which has resulted from the study of the 1914 Report. The Baltimore statistics have been made available for Committee use through the courtesy of the United Railways and Electric Company of Baltimore, and are given herewith as Appendix **A** of this report.

Bearing Power of Soils

The first conclusion given in the 1914 report is as follows:

The question of proper foundation for tracks in paved streets requires the most careful study of the soil in the streets, with respect to their bearing values.

The discussion in Convention confirms this conclusion and emphasizes the importance of continuing the investigation of this most important factor in foundation design. The work of the Joint Committee of the American Railway Engineering Association and the American Society of Civil Engineers on Stresses in Railroad Tracks has now been under way for some time and considerable progress has been made.

Further experiments along this line by the Engineering Experiment Station of Pennsylvania State College are reported in the *Engineering Record,* Vol. 71: 11: 330, May 13, 1915. The Committee on Roadway, of the American Railway Engineering Association made a progress report on Unit Pressures Allowable on Roadbed of Different Track Materials, and quotes a letter to said Committee from the Hon. George Otis Smith, Director of the United States Geological Survey, which further indicates the importance of the subject. (Bulletin No. 173, *American Railway Engineering Association,* January, 1915 — page 574.)

Classification of Soils

That Committee also pointed out the value of a proper classification of soils and presented a conclusion that a classification of soils as given on page 579, of Bulletin No. 173 be adopted. This classification is that given by the United States Department of Agriculture in Bulletin No. 84, Messrs. Fletcher and Bryan. It is presented herewith, together with screens to be used in making the classifications by mechanical analysis, also given by the said Committee.

Key	MATERIAL	Size		Screens	
		mm.	mm.	Pass through	Retain on
1	Fine gravel	2.	1.	No. 10	No. 18
2	Coarse sand	1.	0.5	" 18	" 32
3	Medium sand	0.5	0.25	" 32	" 70
4	Fine sand	0.25	0.10	" 70	" 160
5	Very fine sand	0.10	0.05	" 160	" 230
6	Silt	0.05	0.005	.....	.....
7	Clay	0.005	0.0000	.....	.....

By the number of sieve is meant the number of meshes per lineal inch of wire cloth, woven from brass wire, having the following diameters for

	Diameters
Sieves Nos. 10 and 18	0.0165 inches.
Sieve No. 32	0.0112 "
Sieve No. 70	0.0045 "
Sieves Nos. 160 and 230	0.0024 "

The mesh should be regular in spacing, and the cloth should be mounted on the frame without twisting. The last two sub-divisions, silt and clay, are more difficult to determine, but the method is fully set forth in Bulletin No. 84, Bureau of Soils, Department of Agriculture, above referred to. If the above subdivisions are adopted, we can then classify various soils by giving the percentage of the materials contained. The percentage of water contained in each sample of soil should also be determined by weighing, drying and re-weighing, as the moisture content has a decided influence on the bearing power of many soils.

In reference to the foregoing on bearing power of soils it is the opinion of the Committee, that it should recommend the adoption of this Classification of Soils and Method of Mechanical Analysis for inclusion in the Engineering Manual, together with a "Conclusion", stating that the classification of soils found in average city streets is desirable. It is suggested that way engineers make such analysis of soils in a few of their streets where both good and poor results have been obtained in connection with the use of their standard track foundations.

Multiplicity of Designs of Foundation and Track Construction Now in Use

Attention is called to the great variety in designs of track construction for paved streets now in use. Many of these designs, however, differ only in comparatively minor details.

For the purpose of record and availability for study the designs used by a number of companies are included as Appendix **B** of this report.

Conclusions

The Committee is of the opinion that Type "D", as shown in the report of 1914, p. 487, Fig. 3, should be eliminated and Type "C" substituted where sub-soil conditions require the distribution of load that has been sought by the use of Type "D" and where the expense of such construction is warranted.

The Committee is also of the opinion that Type "A" as shown in the 1914 report, p. 487, Fig. 3, should and recommends that it be eliminated for the reason that there are very few localities where it can be successfully used and there are conditions where it might be used unadvisedly.

Your Committee is of the opinion that the proper classification of soils found in average city streets is desirable and way engineers should make such analyses in connection with decisions as to proper types of track foundation to be used on their properties.

Recommendations

Your Committee recommends for adoption as a Recommended Design of this Association Type "B" Track Construction, as included in report of 1914, and slightly modified as shown in Fig. 2.*

* Formally approved by both the Committee on Standards and the 1915 Convention.

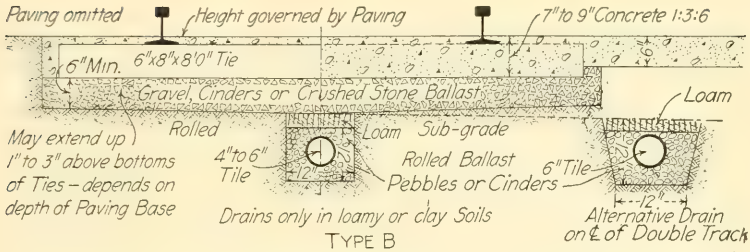

Paving omitted
Height governed by Paving
7" to 9" Concrete 1:3:6
6" Min.
6"x8"x8'0" Tie
Gravel, Cinders or Crushed Stone Ballast
Loam
Rolled
Loam
Sub-grade
May extend up 1" to 3" above bottoms of Ties – depends on depth of Paving Base
4" to 6" Tile
Rolled Ballast
Pebbles or Cinders
6" Tile
12"
Drains only in loamy or clay Soils
Alternative Drain on ℄ of Double Track
TYPE B
For most Soils except very heavy Clays – Heavy Traffic and heaviest Cars up to 35 Tons
Provide Surface Drains

FIG. 2.

Your Committee also recommends for adoption as a Recommended Design of this Association Type "C" Track Construction shown in Fig. 3, for conditions of soil that require a form of construction that distributes the load over the sub-soil more effectively than Type "B".*

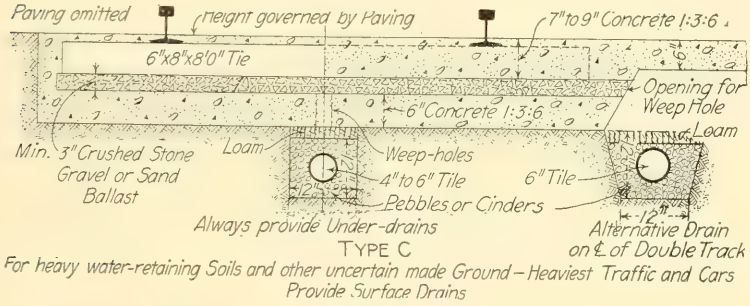


FIG. 3.

The Committee also recommends the adoption as a Recommended Practice the Classification of Soils and Screens to be used in making classifications by mechanical analysis as given on page 8 for inclusion in the Engineering Manual.*

PAVEMENT FOR USE IN CONNECTION WITH GIRDER RAILS

It will be noted that the subject as assigned was Pavement for Use in Connection with Girder and High T-Rails. This has been changed to read as above for the reason that the term "High T-Rail" has been misinterpreted and confused with the low rails ordinarily used in steam road practice, whereas the high rails are more properly classified as girder rails.

The matter of recommendation by this Committee on pavements for use in connection with street railway tracks is so broad and paradoxically so local that it is hardly possible to make a recommendation with-

* See page 517 for action of Committee on Standards.

out a more thorough investigation than the time assigned to the Committee warrants or the time which the individual members are able to give in connection with their other work, together with considerable expense attached to such an investigation, as would enable them to make a thorough report.

The 1914 Committee on Way Matters recommended that:

As it is of such vital moment when considering the fact that maintenance of pavement comprises substantially one-third the total cost of track up-keep, the Committee recommends that a standing committee be appointed with power to make a thorough personal investigation of pavements in American cities.

The Engineering Association evidently did not see fit to follow this recommendation and the result is that the following Committee is merely scratching the surface of this important subject as has been done since the Way Committee's Report of 1909.

In 1910 no mention is made of this subject in the Committee's Report and it was only touched upon at the annual meeting by a paper on "Maintenance of Way" submitted as an Appendix (Page 105 of 1910 Proceedings).

In 1911 and 1912 no investigation was made by the Committee on Way Matters and in 1913 the following paragraph appears in the Committee's report:

The Committee has not been able to give this subject the attention it deserves and is not prepared with a report thereon. The subject is therefore recommended for attention of the ensuing Committee.

The 1914 Committee reported as quoted above, and made a strong plea for the taking of traffic records and submitted forms for the collection thereon.

Traffic Counts

Traffic counts were taken in the following seven cities:

Chicago, Cincinnati, Washington, Brooklyn, Syracuse, Montreal and Anderson, Ind.

A general summary of these traffic counts has been tabulated and is attached hereto as Appendix **C** of this report.

The results indicated on this summary show that the form submitted in last year's report did not entirely answer the requirements of taking traffic counts from a street railway standpoint. Accordingly the Committee submits a modified form as shown — Appendix **D**.

Attention is called to an article by Mr. P. E. Green in the Proceedings of the American Society of Civil Engineers, page 123, Vol. 72, in which he divides this subject into three classes, which seems to cover practically the entire subject, with the exception that he does not divide the vehicular traffic in the roadway space. He classifies the traffic as follows:

(*a*) Much light, fast traffic.
(*b*) Heavy hauling.
(*c*) Only local hauling.

The principal item of interest to street railway engineers is the proportion of traffic which the track space bears to the balance of the roadway.

The next item in the selection of the pavement is to choose one which is the most durable in the track space. These two items can be innumerably divided into wearing qualities, finances, aesthetic reasons, proximity of supplies, etc. Reference to the summary of the traffic counts indicates that there is no definite relation between the width of roadway, kind or condition of pavement, class of vehicular traffic or kind of rail, in the various cities from which counts were obtained. However, it will be noted that on the wide roadways a smaller percentage of traffic uses the track space than in the narrower roadways. Habit seems to have more bearing on the use of the track space by vehicular traffic than in any other one item. For instance, the lowest percentage of vehicles on the track space is noted in Montreal, but the track space carries the highest number of cars. The highest percentage of vehicles on the track space is noted in Syracuse, which also has the narrowest roadway, with a reasonably heavy car traffic.

To be of any value in the selection of pavement traffic counts should be carried on over a series of years during the life of the pavement, record being made during the original construction, of the sub-soil, drainage, kind of paving, foundation, the foundation of the track, the kind of rail, the manner in which the paving is laid, the quality of material, the vehicle and car traffic, the habit of the vehicles in keeping in the roadway or track space, the kind and quality of the paving material, noting in the counts subsequent to the first, the rate of wear if possible and how, when and where deterioration sets in and its possible causes.

Particular attention is called to the evolution in classes of vehicles which are using the streets, from horse drawn with steel tires to rubber tired motor vehicles. Coincident with this the weights and speed of vehicles is materially increasing.

Kind of Pavements

As the matter of the selection of the pavement resolves itself into one of purely local character and in most instances as local as individual streets, engineers of street railway companies, in making such selection should investigate carefully:

First. Vehicular traffic, present and estimated.

Second. Car traffic, present and estimated.

Third. Grade and crown of the street.

Fourth. The class of property adjacent.

Fifth. The ability of the Company to afford the best material.

Sixth. Type of rail.

Seventh. Proximity and cost of material, comparing the maintenance and renewal of the poorer quality with the better quality of pavement.

It is the consensus of opinion of the members of this Committee that a unit pavement is superior to that of a monolithic or sheet pavement and it believes that this opinion is very general amongst street railway engineers. This opinion is also probably shared by a large number of municipal engineers and the *Engineering News* of February 25, 1915, contains a statement from H. W. Durham, Chief Engineer, Bureau of Highways, New York, extracted from his annual report which is based on a study of experience in all parts of the world and is as follows:

Granite block pavements with close joints is the only satisfactory pavement for use between rails of car tracks.

A canvass of the opinion of the members as to the relative usefulness of the various kind of paving in car tracks, indicates the following:

First. Granite block.
Second. Medina sandstone block.
Third. Treated wood block.
Fourth. Brick, Vitrified.
Fifth. Scoria block.
Sixth. Asphalt block.
Seventh. Sheet asphalt.
Eighth. Bitulithic.
Ninth. Bituminous Macadam.
Tenth. Sandstone block, inferior to Medina quality.
Eleventh. Water bound Macadam.

GRANITE BLOCK:

Granite block paving in its various types seems to rank as the best pavement adjacent to rails of street railway tracks. The kind and quality of granite has not to the knowledge of the Committee, been specified, except perhaps the standard specifications which are approximately as follows:

The block shall have a uniform grain and texture without laminations or stratification and free from an excess of mica or feldspar, soft or weather worn stones obtained from the surface of the quarry and stones which wear to a polish under traffic, shall not be used.

The size of the block is a matter which has not been determined. It is obvious by specifying any particular composition of granite that it would limit the production to very few quarries, which might or might not be in economical proximity to the site of the work. It is further a consensus of opinion that the blocks should be laid with close joints and should be substantially rectangular. All first-class granite blocks should have a dressed face and bed. A great deal of attention has been attracted to the type of granite block pavement known as "Durax", which is a block dressed substantially as a cube. As to its use in street railway work very little is known in this country. However, we believe that European tramways have found

this type of granite paving quite satisfactory. It is further conceded that the joints in granite block paving adjacent to the tracks should be filled with a cement grout, or pitch filler. In order to cheapen a granite block paving it might not be necessary, in instances to lay the entire track with granite block but only place it adjacent to the rail and should be laid as headers, except on the outside of the rail where a sheet paving adjoins the track paving; this should be laid as stretchers or headers without toothing. Cushions of various kinds have been suggested but should be as follows in order of their utility:

First. Dry grout.
Second. Sand.
Third. Stone dust or grits.

MEDINA OR SANDSTONE OF EQUAL QUALITY:

This product as a paving material ranks next to granite but the production is largely local and we believe that the cost outside of a limited area would be prohibitive.

WOOD BLOCK:

This material, if properly laid, makes a very satisfactory pavement. We believe that a recommendation as to a specification covering the proper wood and treatment, proper manufacture, method of laying and kind of foundation and filler should be a part of the recommendation of a future Committee.

BRICK:

This class of paving material is perhaps more generally used than any other in track space particularly because of its relative cheapness, the ease with which it is laid and its adaptability without waste in track space. On light traffic streets it can be successfully used adjacent to rails. The various manufacturers have many specifications and methods of manufacture. At present wire cut blocks are very much in vogue.

It would probably be well to have a general standard specification covering its manufacture, composition and testing which should be broad enough to include the various types of brick now being manufactured.

SCORIA BLOCK:

The use of this material as a paving in this country is very limited. We believe only four or five cities have had much experience with it. The principle trouble with scoria is its lack of uniformity and texture and its extreme brittleness. If the blocks were made and tested under a standard specification their wearing qualities would without doubt be greater than brick. We believe that some efforts have been made to manufacture this block in this country, but without success; the majority of it is being imported from Scotland.

ASPHALT BLOCK:

There seems to be a very small amount of this pavement used in tracks. Observations taken on 2nd Avenue between 15th and 17th Sts., New York City would indicate that its value over that of sheet asphalt is somewhat doubtful.

ASPHALT:

The experiences of the various Committee members, both in their own cities and from observations in others, is that this is not a satisfactory paving adjacent to the track. It is also quite expensive in comparison with the cheaper block pavements. Attention probably will at once be called to the condition of the asphalt adjacent to the track in New York City, but we think that the reason for the condition of the asphalt pavement in that city is due to constant maintenance.

A paper read before the Engineering Association states that its maintenance in track space is much higher than either wood block or granite, being as high as 55 cents per square yard per year, granite being as low as 27 cents per square yard per year. Asphalt should be avoided on streets with heavy grades or severe crowns.

BITULITHIC:

This pavement should be put in the same class as asphalt except that it is easier and less expensive to maintain and does not require an asphalt plant for its installation or repair.

BITUMINOUS MACADAM:

This material is suitable for the paving of outskirts of cities where vehicular traffic is light. It can be maintained at a moderate cost but costs more in the long run than brick paving and is satisfactory on streets with moderate grades. The principal difficulty is the replacement of this material.

SANDSTONE BLOCK — INFERIOR TO MEDINA:

From the experience of the Committee members with sand-stone block, and their observations in New York City, this is a paving material which, adjacent to the track, ranks ahead of asphalt block. Its liability to disintegration makes it of doubtful value.

WATER-BOUND MACADAM:

This class of pavement, if properly made is satisfactory for small municipalities or out-lying districts of cities. Substantial repairs are not easily made and it should only be used as a temporary filling prior to future permanent pavements.

CONCRETE PAVEMENTS:

This class of pavement has been in use so short a time, particularly about car tracks, that but little is known of its utility. From the

experience of various members of the Committee it is not to be recommended. The impracticability and expense of maintenance, its tendency to expand and break up and the rapidity of wear, under the present conditions make it a very unsatisfactory pavement.

Bibliography

Attention is called to a brief bibliography on this subject which appears as Appendix **E** of this report.

Conclusions

Too much stress cannot be laid on the methods of installation of any paving. So much of the wear and life of paving depends on its proper installation and after installation its inspection and maintenance; all of which if properly done, would make a satisfactory paving suitable to the local conditions governing its selection.

A matter which should be considered by future Committees is the formulation of a specification covering the manufacture and installation of the various types of paving which might be used in connection with the car tracks.

The matter of proper foundation should also be incorporated in such specifications and also the type of filler and cushions.

Recommendations

The Committee recommends that the Engineering Association should request Member Companies to keep careful records of new paving installation in tracks, together with yearly maintenance costs of such installation, and submit same to the Association from time to time, as requested by the Committee on Way Matters in order that subsequent Committees may have data of this sort with which to work.

Your Committee also recommends

(*a*) That the Executive Committee's attention be again called to the importance of this subject; and

(*b*) A standing committee be appointed and empowered to make such expenditures as may be necessary for a thorough and complete investigation of the subject of Pavements for Tracks in Streets.

SPECIFICATIONS WITH DEFINITIONS FOR SUNDRY TRACK MATERIALS SUCH AS TIES, TRACK SPIKES, BOLTS, TIE RODS, TIE PLATES, ETC.

Your Committee recommends that this subject be continued for the 1916 Committee, for the reason that the A. S. T. M. expects to offer specifications for these materials during 1916 and your Committee decided that it would be wise to delay action in order to permit coöperation with the A. S. T. M. and possibly adopt their specifications.

It further recommends that our Secretary be authorized to advise the A. S. T. M. of our desire to coöperate in the preparation of the above mentioned specifications.

SPECIFICATIONS FOR SPECIAL WORK

A committee representing several special work manufacturers of which Mr. V. Angerer was chairman, coöperated with your Committee in the preparation of the Specifications for Special Work. Your Committee is greatly indebted to the members of above Committee for their work and takes this opportunity of expressing its appreciation.

Your Committee recommends for adoption, as Recommended Specifications, the following general Specifications for Special Work for electric street railways.

It is also recommended that this subject be continued for the purpose of preparation of standard specifications for types of special work not yet covered, as well as consideration of matters in connection with standard layouts.

SPECIFICATIONS FOR SPECIAL WORK

(Recommended for Adoption as Recommended Specifications.*)

I Material

MANGANESE STEEL:

1 (*a*) *Chemical Composition.* The chemical composition of cast manganese steel shall be within the following limits:

Manganese	10.00 to 14.00%
Carbon	1.00 to 1.40%
Phosphorus, not more than	.10%

Drillings from the finished articles shall be furnished for check analysis if so specified by the purchaser. When specified a test coupon is to be cast with the casting in the mold, removed and key marked by the inspector before heat treatment and heat-treated with the special work casting.

(*b*) *Physical Qualities.* The above mentioned coupon six (6) to ten (10) or twelve (12) inches by one (1) inch by three-quarter (¾) inch shall bend cold on the flat side around a diameter of one (1) inch to an angle of 180 deg. without breaking. The bending may be accomplished by pressure or by blows.

(*c*) Bending test demonstrations from the test coupons, if specified by the purchaser, shall be made in the presence of his representative at the foundry where the castings are made.

CAST STEEL FOR TRACK CASTINGS:

2. (*a*) *Chemical Composition.* The chemical composition of cast steel for track castings exposed to wheel wear shall be

Carbon	.45 to .55%
Silicon	.30 to .40 %
Manganese	.60 to .80%
Sulphur, not over	.05%
Phosphorus, not over	.05%

*Formally approved by both the Committee on Standards and the 1915 Convention.

(*b*) *Physical Qualities.* The physical quality of castings shall be in accordance with the standard specifications of the American Society for Testing Materials for hard steel castings.

CAST STEEL FOR CASTINGS NOT EXPOSED TO WHEEL WEAR:

3 (*a*) *Chemical Composition.* The chemical composition of steel castings used in connection with special track work, but not exposed to wheel wear, shall be approximately

Carbon	.20 to .30%
Sulphur, not over	.05%
Phosphorus, not over	.05%

(*b*) *Physical Qualities.* The physical quality shall be in accordance with the standard specifications of the American Society for Testing Materials for medium castings.

CAST IRON:

4. (*a*) For the bodies of track castings, cast iron shall be of a composition combining strength with hardness sufficient to withstand the abrasive effect of street traffic on the exposed surfaces. The minimum transverse breaking strength of bars made to specifications of the American Society for Testing Materials shall be thirty-eight hundred (3800) pounds applied in the center between supports twelve (12) inches apart.

(*b*) Cast iron for castings in connection with special track work other than the bodies of track castings shall be in accordance with standard specifications of the American Society for Testing Materials for medium gray castings.

RAIL:

5. (*a*) Girder rail shall be in accordance with the specifications of the American Electric Railway Engineering Association (Engineering Manual Wr 2c.) either Grade A or B.

(*b*) Girder guard rail to be in accordance with Class A first quality rail of the American Electric Railway Engineering Association Specifications for Open Hearth Girder Rails (Engineering Manual Wr 2c).

(*c*) Standard Section rail shall be in accordance with the American Railway Engineering Association specifications for first quality rail, Open Hearth or Bessemer steel, as specified.

SPLICE BARS:

6. (*a*) For Girder Rail shall be in accordance with specifications of the American Electric Railway Engineering Association (Engineering Manual Wm 3a). Either Grade A or B as specified.

(*b*) For Standard Section rail shall be of angle bar type where practicable, made in accordance with the American Society for Testing Materials specifications and of such quality as may be specified.

BOLTS:

7. All bolts subject to severe strains and which are so specified or shown on the drawing shall be of steel of the following minimum requirement:

Ultimate tensile strength	100,000 lb. per sq. in.
Elastic limit	75,000 lbs. per sq. in.
Elongation in 2 in	15%
Reduction of area	40%

When specified by the purchaser a nut locking device shall be furnished.

FORGED AND ROLLED STEEL:

8. Forged or rolled steel in parts of special work receiving wheel wear shall be of a quality equal to the rail steel with which it is used. Steel for parts not receiving wheel wear shall be ordinary commercial mild steel.

II General Requirements and Finish

CASTINGS:

9. Castings shall be reasonably smooth and true to pattern in accordance with good foundry practice. Large lumps, sharp fins, sand and chills on the outside of castings shall be removed. The castings shall be free from blow holes, sand holes, cracks, cold shuts or other defects which in the inspector's judgment would impair their serviceability. Castings must be out of twist and reasonably true, both as to general surface and alignment, and must not show any signs of straining or undue denting produced in the straightening process. Castings shall not be painted prior to inspection, nor shall any effort be made to conceal or rectify defects.

RUNNING SURFACES:

10. Running surfaces of castings shall be finished to as good surfaces as those of rolled rail.

BOTTOM OF CASTINGS:

11. The bottom part of castings which rest on ties shall be straight and out of twist and shall be free from lumps or such imperfections as would prevent a good bearing.

JOINTS:

12. Where castings connect directly with rails, they shall be finished for a tight fit of standard splice bars throughout the length of such bars and projecting portions of castings taking the place of joint plates shall be finished to a splice bar fit. When joints are bolted up tight, the rail shall align correctly with the castings with no greater variation that one thirty-second (1/32) inch in either line or level. For joints between castings, special splice bars may be used only when impossible to apply standard bars and the finish shall

then be maintained equally good. Joints shall be tight. Occasional open joints shall not exceed one-eighth (⅛) inch. Manufacturers shall make note of such open joints on drawings.

COMPROMISE JOINTS:

13. (*a*) Compromise joints shall be avoided wherever possible by shaping the ends of special pieces to match the adjoining rail, or compromise rails shall be used consisting either of steel castings or two pieces of rails connected by cast welding or other welding method, and shaped on the two ends to suit the respective sections to be joined. Such compromise rails shall be not less than five (5) feet long over all.

(*b*) Where the foregoing practice is not specified or practicable, compromise joints shall be of forged or cast steel at least equivalent in strength to the joint for the lower rail and must be finished to a good fit, so that good line and surface are obtained.

(*c*) Compromise joints shall be designated in accordance with the recommended practice of the American Electric Railway Engineering Association (Engineering Manual Ws 3a).

(*d*) Where girder guard rails connect with other sections the shape of the guard shall be modified in a distance of six (6) to nine (9) inches to conform gradually and as nearly as practicable to the contour of the connecting section.

PAVING FACE:

14. In work specified for paved streets the angles in switches, mates and frogs shall be filled to provide paving faces to a width of not less than four (4) inches by carrying out the castings forming the body of the piece where length of arms and joints will permit. Where this is not possible, paving chocks shall be used consisting of separate iron castings which must have ample bearing on the bottom flanges of the special pieces and rails to prevent their being depressed under vehicular traffic and to be so constructed as to permit their being placed and solidly grouted after the joint plates are applied.

LINE AND SURFACE:

15. The line and surface of all work shall be practically true and uniform throughout, with no greater variation than one-sixteenth (1/16) inch in five (5) feet of length.

GROOVES AND GAUGE:

16. Groove and gauge shall conform to the Recommended Practice of the American Electric Railway Engineering Association (Engineering Manual Ws 2a).

WHEEL CLEARANCE:

17. Tread clearance shall be four (4) inches in width unless otherwise specified.

FLANGE BEARING:

18. The depth of grooves at intersections and on curved side of mate points shall be one-sixteenth (1/16) inch less than the depth of the wheel flange. Wherever possible the flange bearing shall be carried to a point where the wheel will have not less than two (2) inches tread bearing. The effective part of risers approaching the flange bearing shall not be steeper than one-sixteenth (1/16) inch in one (1) inch of length and shall be made a maximum of one-thirty-second (1/32) inch in one (1) inch of length whenever possible.

LENGTH OF SWITCHES AND MATES:

19. Tongue switches and mates shall be of Manufacturer's Standard lengths unless otherwise specified.

INSPECTION:

20. The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy himself that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment unless otherwise arranged.

III Solid Manganese Steel Construction. (For Girder rail)

TONGUE SWITCHES, MATES, FROGS AND CROSSINGS:

21. Tongue switches, mates, frogs and crossings shall be made of manganese steel castings of uniform design, with extremities to conform to the connecting rail. The castings shall be uniform in depth of six (6), seven (7), or nine (9) inches and not less than the highest of the connecting rails and of a section in which the thickness of metal will not be below the following dimensions:

Under treads, 1½ in.
Under grooves, ½ in.
Under grooves at flange bearing, 1½ in.
Vertical walls or webs ⅝ in. in double webs.
Vertical walls or webs, ½ in. in single web.
Base flange ⅜ in. at outer edge; ¾ in. at web.

Base flanges shall be not less than three (3) inches wide on each side of double web sections and five (5) inches wide on single web sections. Angles in castings are not permissible, all must have fillets. All holes shall be cored, and smooth and accuratey located. Where drilled holes, as for electric bonds, are required, soft iron or steel plugs may be inserted in the casting.

TONGUE SWITCHES:

22. The tongues in tongue switches shall be provided with lateral flanges to promote lateral stiffness, with a construction at the heel that will furnish adequate bearing and give a secure and adjustable fastening. There shall be provision for attaching throwing or con-

trolling mechanism and the box containing same to either side of the switch. The tongue shall be arranged for such attachment when specified. Provision shall also be made for attaching a cleaning box to the switch casting opposite the throwing device and opening shall be provided in the tongue bed for proper drainage. All bearing parts of the tongue and switch bed shall be properly finished to a good surface. The tread of the tongue shall be at least one-quarter (¼) inch above the curved tread of the switch, from one (1) foot from tongue point to give an effective guard where required. Switch tongues shall be finished so that practical interchangeability is assured.

MATES:

23. Mates to be uniform in length with tongue switches. Both tongue switch and mate castings shall be open on top at the heel ends for convenience of setting joint bars.

FROGS AND CROSSINGS:

24. (*a*) The length of frog and crossing arms shall be sufficient to give at least six and one-quarter (6¼) inches clearance between vertical webs at end of joint plates with a minimum length of three (3) feet unless adjoining piece will not permit.

(*b*) Single crossings to be cast in two (2) pieces in angles from 90 to 60 deg., and in four (4) pieces for angles under 60 deg. In two (2) piece crossings or compound pieces the length of arms shall be kept under four (4) feet six (6) inches. Castings shall not exceed a maximum of sixteen (16) feet in length.

IV CAST STEEL WITH HARD CENTER CONSTRUCTION. (FOR GIRDER RAIL)

TONGUE SWITCHES, MATES, FROGS AND CROSSINGS:

25. (*a*) Tongue switches, mates, frogs and crossings shall consist of cast steel bodies, the extremities conforming to the adjoining rail and have hard steel centers secured to the bodies. The bodies shall be of uniform depth of six (6), seven (7) or nine (9) inches and not less than the highest of the connecting rails and be provided with a base flange not less than three (3) inches wide on each side of double web sections and five (5) inches wide on single web sections.

(*b*) The sections shall provide minimum thickness of metal as follows:

Thickness under grove, ⅞ in.
Thickness under center, ⅞ in.
Thickness of vertical walls or webs, ⅝ in. for double webs.
Thickness of vertical walls or webs, ¾ in. single webs.
Thickness of base, ½ in. at outer edge, ¾ in. at web.

The centers shall be not less than two (2) inches thick from tread surface to bottom of centers with a minimum thickness under the groove of three-quarters (¾) inch and shall be of such length as to provide for a full tread at the ends where they join the cast steel

bodies. No center to be shorter than twelve (12) inches measured on the gauge lines. The centers shall be fastened to the bodies by an efficient method, and in frogs and crossings shall be renewable. Hard center inserts shall have either a partial or full machine bearing when specified. The running surface of hard centers must be finished to a true level with the adjoining body castings.

TONGUE SWITCHES:

26. The switches shall be provided with a hard steel bed plate, also forming the running portions of the switch and extending beyond both ends of the tongue. The tongue shall be of hard steel provided with lateral flanges to promote lateral stiffness, and be constructed at the heel to give an adequate bearing with a secure and adjustable heel fastening. There shall be provision for attaching throwing or other controlling mechanism and the box containing same to either side of the switch. The tongue shall be arranged for such attachment when specified. Provision shall also be made for attaching a cleaning box to the switch castings opposite the throwing device and openings shall be provided in the tongue bed for proper drainage. All bearing parts of the tongue and switch bed shall be properly finished to a good surface. The tread of the tongue shall be at least one-quarter (¼) inch above the curved tread of the switch, from one (1) foot from tongue point to give an effective guard where required. Switch tongues shall be finished so that practical interchangeability is assured.

MATES:

27. Mates shall be uniform in length with the tongue switches and conform to the general construction. The centers in mates need not be renewable. The heel ends of both tongue switches and mates shall be open on top for convenience in setting joint bars.

FROGS AND CROSSINGS:

28. (*a*) The length of frog and crossing arms shall be sufficient to give at least six and one-quarter (6¼) inches clearance between vertical webs at end of joint plates with a minimum length of three (3) feet, unless adjoining piece will not permit.

(*b*) Single crossings to be cast in two (2) pieces in angles from 90 to 60 deg. and in four (4) pieces for angles under 60 deg. In two (2) piece crossings or compound pieces the length of arms shall be kept under four (4) feet six (6) inches. Castings shall not exceed a maximum of sixteen (16) feet in length.

V ROLLED RAIL ARMS, IRON BOUND, WITH HARD-CENTER CONSTRUCTION

TONGUE SWITCHES, MATES, FROGS AND CROSSINGS:

29. Tongue switches, mates, frogs and crossings shall consist of rolled rail arms bound together by a cast body with a recess to receive

a hard steel center which shall form the running portions of the structure between the rolled rail arms. The body portion shall be of a section giving not less than one and one-quarter (1¼) inches thickness of metal underneath the hard steel center not less than one and three-eighths (1⅜) inches thickness of walls and not less than six (6) inches total width of bearing surface on the ties. It shall be provided with a spiking ledge on the outside. The minimum depth of the body portion shall be seven (7) inches. The centers shall be not less than two (2) inches thick from tread surface to bottom of centers, with a minimum thickness under the grooves of three-quarter (¾) inch. They shall be fastened to the body portion by an efficient method, and in frogs and crossings shall be renewable. Hard center inserts shall have either a partial or full machine bearing when specified. The running surface of hard centers must be finished to a true level with the adjoining rolled rail.

TONGUE SWITCHES:

30. The switches shall be provided with a hard steel centre at the point of, and a hard steel bed under the entire length of the tongue. The tongue shall be of hard steel provided with lateral flanges to promote lateral stiffness, and be constructed at the heel to give an adequate bearing with a secure and adjustable heel fastening. There shall be provision for attaching throwing or other controlling mechanism and the box containing same to either side of the switch. The tongue shall be arranged for such attachment when specified. Provision shall also be made for attaching a cleaning box to the switch castings opposite the throwing device and openings shall be provided in the tongue bed for proper drainage. All bearing parts of the tongue and switch bed shall be properly finished to a good surface. The tread of the tongue shall be at least one-quarter (¼) inch above the curved tread of the switch, from one (1) foot from tongue point to give an effective guard where required. Switch tongues shall be finished so that practical interchangeability is assured.

MATES:

31. Mates shall be uniform in length with the tongue switches. The hard steel wearing plate shall include the guard as well as the running surfaces and be of sufficient length to provide at least a two (2) inch tread at both ends. The hard steel wearing plate in mates need not be renewable.

FROGS AND CROSSINGS:

32. (*a*) Frog and crossing arms shall be long enough to give six and one-quarter (6¼) inches clearance between webs at end of joint plates. When adjoining pieces, or a combination of pieces, prevent

a length of arm for proper joining, pieces made of cast steel with hard steel center, or solid manganese steel may be substituted at the manufacturer's option.

(*b*) Crossings shall be in one (1) and (2) pieces, or in small angles, in four (4) pieces, at manufacturer's option. Outside crossing arms shall be not less than three (3) feet unless joined to other pieces necessitating shorter lengths.

(*c*) The hard steel center plate shall be of sufficient length in all cases to provide a full tread at the junction with the rolled rails and no centre shall be less than twelve (12) inches long, measured on the gauge line.

BINDING:

33. The rail arms must be secured in the body casting by proper means and an adequate amount of the cast metal along the webs of the rail to assure their being held absolutely tight and to give proper strength to both the rail arms and the body casting.

REVISION OF RECOMMENDED DESIGNS OF SEVEN AND NINE INCH JOINT PLATES, WITH SPECIAL REFERENCE TO SIZES OF BOLT HOLES AND FITS

This subject was considered a very broad one and the Sub-committee at its meetings was unable to make much progress. Endeavors were made to secure tests, but were unsuccessful.

Your Committee therefore recommends the continuance of this subject to the ensuing Committee in order that more time may be available and proper tests may be obtained.

Your Committee also recommends that the title of this subject be changed to read, "Designs for Drilling of Rails and Joint Plates and their Application."

JOINTS FOR SEVEN-INCH PLAIN GIRDER RAILS

It is noted that the Manual shows no designs of mechanical joints for 7-in. plain girder rails. The manufacturer's designs are subject to nearly the same criticisms as were their designs for girder groove and guard rails The accompanying drawing, Fig. 6, shows a design of a "bridge" type joint for the 7-in 91 lb. plain girder rail, which is designed along the lines of the Association designs for girder joints. It is recommended (a) that this design be adopted as a Recommended Design* and inserted in the Manual, and (b) that the same design be adopted as a Recommended Design* for the 7-in. 80 lb. plain girder rail.

*Formally approved by both the Committee on Standards and the 1915 Convention.

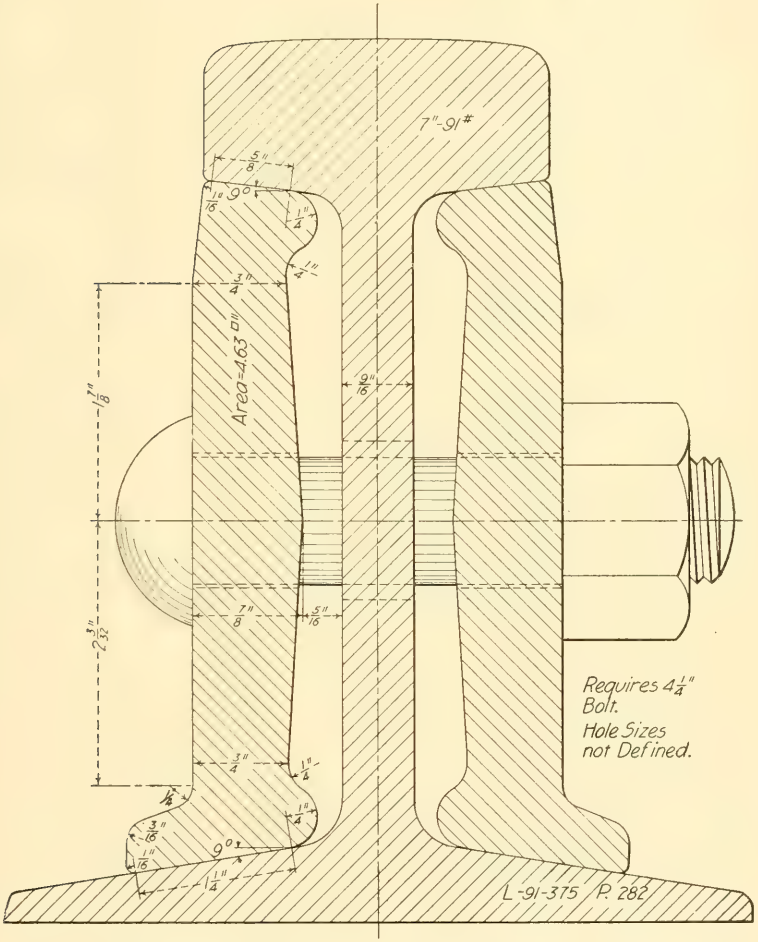


FIG. 6. RECOMMENDED DESIGN OF JOINT FOR 7-IN. 80 LB. AND 7-IN. 91 LB. PLAIN GIRDER RAILS

DRILLING FOR STANDARD SECTION RAILS

In considering the revision of existing designs for standard section rails, it was noted that there had been no recommended standard drilling for these rails. In view of the fact that we have recommended the adoption of certain A. R. E. A. rails, the Committee thinks it opportune for our Association to adopt a standard drilling similar to that adopted as standard by the A. R. E. A. for uniformity in practice.

Your Committee therefore recommends for adoption as a Recommended Design for Drilling of Standard Section Rails as show in Fig. 1, 2 and 3, pages 504 to 506, the designshown in Fig. 7 herewith.*

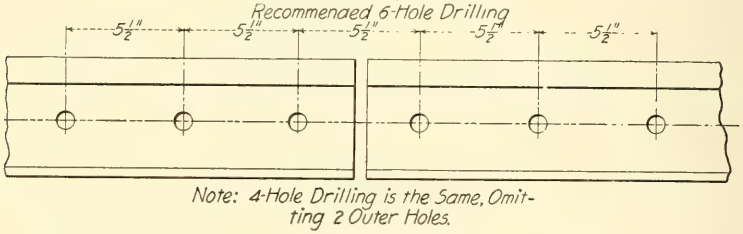


FIG. 7. RECOMMENDED 6-HOLE DRILLING FOR STANDARD SECTION RAILS

REVIEW OF EXISTING STANDARDS AND RECOMMENDATIONS ORIGINATING WITH COMMITTEE ON WAY MATTERS

The Committee at this time recommends that changes be made in the existing Standards and Recommendations as printed in the Engineering Manual as given below:

SEC. WM 2A — RECOMMENDED SYMBOLS FOR RECORDING SURVEYS

In reviewing this subject, we believe that the Symbols for Recording Surveys shown in the Manual Wm 2a are illustrated on too small a scale for practical use.

In view of the fact that the conventional signs adopted by the A. R. E. A. have been accepted and are being used by the I. C. C. in valuation work, we should adopt such of these signs as will serve our purposes. Moreover, the A. R. E. A. signs largely conform to those now printed in the Manual; they are drawn to larger scale, and also contain additional signs, which we should include.

Your Committee recommends (*a*) changing the title which reads, "Recommended Symbols" to read "Recommended Conventional Signs," and that the wording "Symbols for Recording Surveys" be changed to read "Conventional Signs for Recording Surveys." (*b*) That the signs as adopted by the American Railway Engineering Association be adopted by our Association as Recommended Signs with certain modifications, as indicated on the accompanying illustrations which we recommend be inserted in the Engineering Manual in lieu of those in Wm. 2a.†

*Formally approved by both the Committee on Standards and the 1915 Convention.
†See page 517 for Action of Committee on Standards.

HYDROGRAPHY.

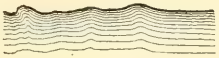
Stream

Springs and Sinks

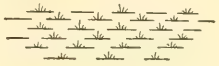
Lakes and Ponds

Falls and Rapids

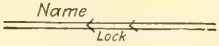
Water Line



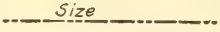
Marsh



Canals

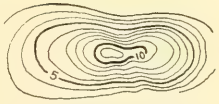


Ditches



RELIEF.

Contour System



Sand

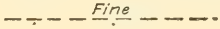
Cliffs

Cut

Embankment

Top of Slope

Bottom of Slope



Note: Relief may be shown in brown (sepia).

* Railways (Topographical Maps.)

Steam

Electrified Steam R.R.

Street Railways

Electric Interurban Railways

Subway

Elevated Ry.

* Railway Tracks (Track Maps.)

Railway Track or Old Track to Remain

Old Track to be Taken up

Proposed Tracks — Red

Proposed (Future) Tracks — Red

Foreign Tracks — Color other than Red or Black with Initials of Road.

Alignment or Radius of Curve { 4° Curve to Right; 2° " " Left } — 4° C.R. 2° C.L.

Boundary and Survey Lines.

{ Political Divisions; State, County or Township Lines. — Bethel Twp.-Wayne Co. Mich. / Posey Twp.-Adams Co. Ind.

{ Government Surveys, Base, Meridian, Township, Section or Harbor Line — Sec. 18. T. 12 N., R. 1 E., 3rd. P.M. / Sec. 13. T 11 N., R 1 E., 3rd. P.M.

Street, Block or other Property Line

Survey Lines — Red: Preliminary / Location

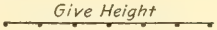
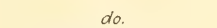
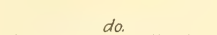
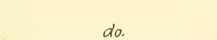
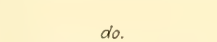
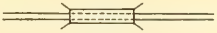
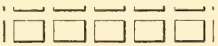
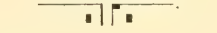
Center Lines — Original (track or section) Center Line lg. If Monumented, Show Location and Proper Symbol.

Company Property Line

Fence (on Street Line) — State Kind and Height

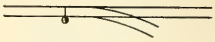
Fence (on Company Property Line) — State Kind and Height

* For Railway Track and Yard Studies Use Single or Double Lines.

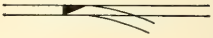
Stone Fence	
Board Fence	
Picket Fence	
Barb Wire Fence	
Rail Fence	
Worm Fence	
Woven Wire Fence	
Snow Fence	
Snow Shed	
City	
Village	
City Limits	
Fire Limits	
Section Corner	
Section Center	
Triangulation Station or Transit Point	
Bench Mark	B.M. × 1232
Stone Monument	□
Iron Monument	■

Track Fixtures.

Turnout and Switch-Stand



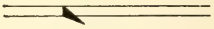
Interlocked Switch



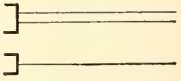
Double Slip Switch

Single Slip Switch

Derail (Mark type)



Bumping Post



* Buildings.

Stone	S	*Indicate Use and Number of Stories.*
Frame	F	
Brick	B	
Concrete	C	
Corrugated Iron	Cor. I.	
Brick Passenger Station	B.P.	
Electrical Sub-Station	S.S.	
Lightning Arrester House	L.A.	

Platform or Driveway — Indicate Kind and Character

Turntable

Interlocking Tower

Ash Pit — A.P.

Coal Chute (Mechanical)

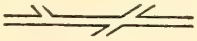
Coal Chute (Trestle) — C. S.

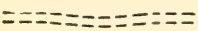
Circular Engine House

Square Engine House — Indicate Kind and Character

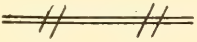
* *Indicate Type and Construction by Combination of Letters, as : F.F. = Freight Frame Station, B.F. = Brick Freight Station.*

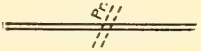
Highways and Crossings.

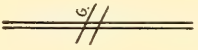
Public and Main Roads 

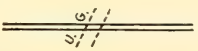
Private and Secondary Roads 

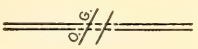
Trails

Street and Public Road Crossings 

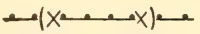
Private Road Crossing 

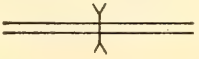
Road Crossing at Grade 

" " under " 

" " overhead 

Crossing Gate

Turnstile 

Cattle Guard 

Farm Gate

Mines.

Tunnel

Shaft

Test Opening

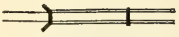
Coal Outcrop

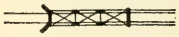
Mine in Operation

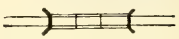
Stone Quarry

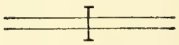
Gravel Pit

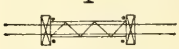
BRIDGES.

Girder 

Truss 

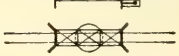
Trestle 

Signal Bridge 

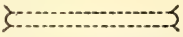
Lift Span 

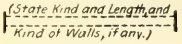
Bascule, Double Leaf

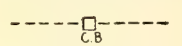
Bascule, Single Leaf

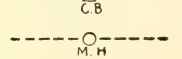
Draw Span 

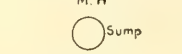
CULVERTS, SEWERS, ETC.

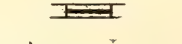
Masonry Arch or Flat Top Culvert 

Pipe or Wood Box Culvert or Drain 

Catch Basin 

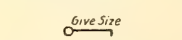
Manhole { Indicate Use by Letter in Circle 

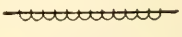
Sump 

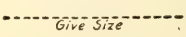
Track Drain 

WATER SUPPLY AND PIPE LINES.

Water Tank

Water Column 

Track Pan 

Company Water Pipe 

Other Water Pipe

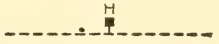
Steam or Gas

Compressed Air

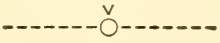
Pipe Line —8"W—4"S—

WATER SUPPLY AND PIPE LINES.
(CONTINUED.)

Fire Hydrant

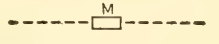


Valve

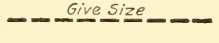


Riser

Meter

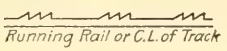


Sewer or Drain

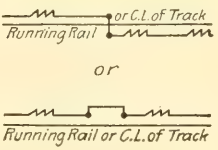


ELECTRICAL CONDUCTORS

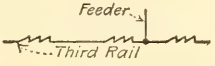
Third Rail



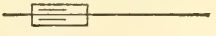
Jumpers.



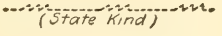
Feeder



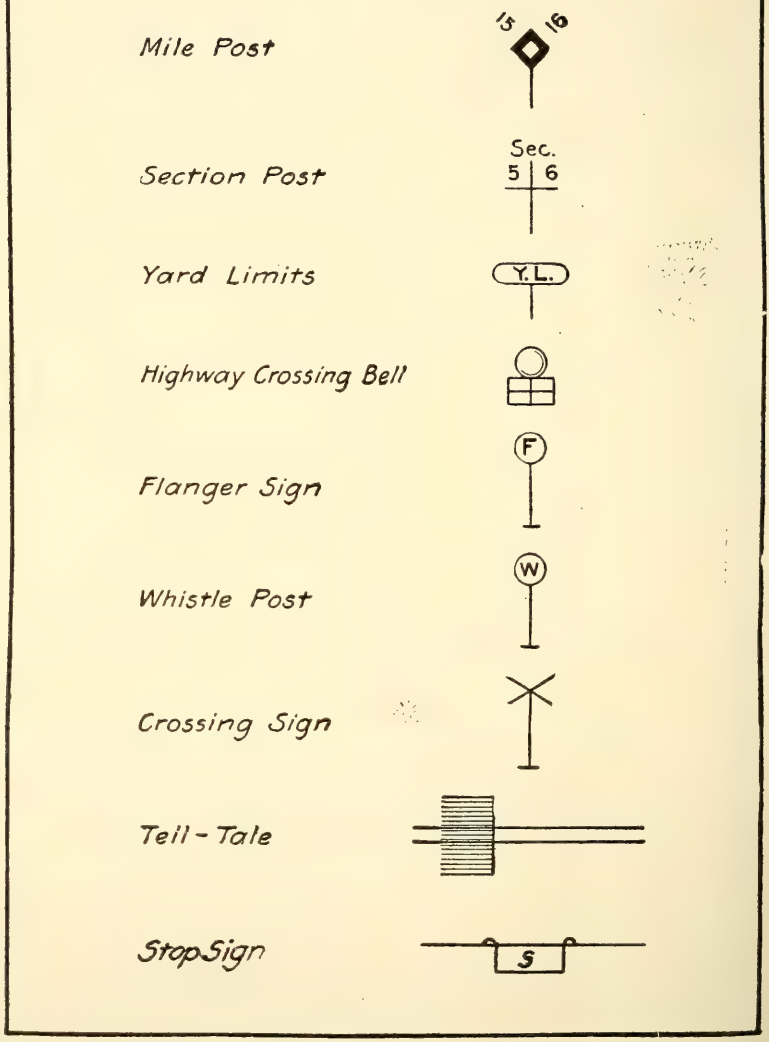
Switch



Overhead Rail or Wire

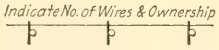


Signs and Signals.

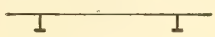


Miscellaneous.

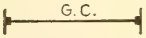
Pole Wire Lines



Rail Rest

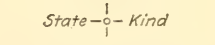


Gantry Crane

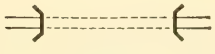


Arc Lamp

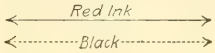
Other Lamps



Railway Tunnel



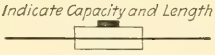
Dimension Lines



Cribbing

Abutment, Wall and Pier

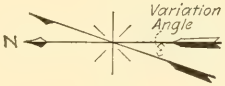
Track Scales



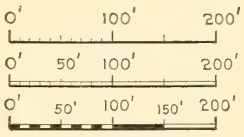
Wagon Scales

Mail Crane

True and Magnetic Meridian



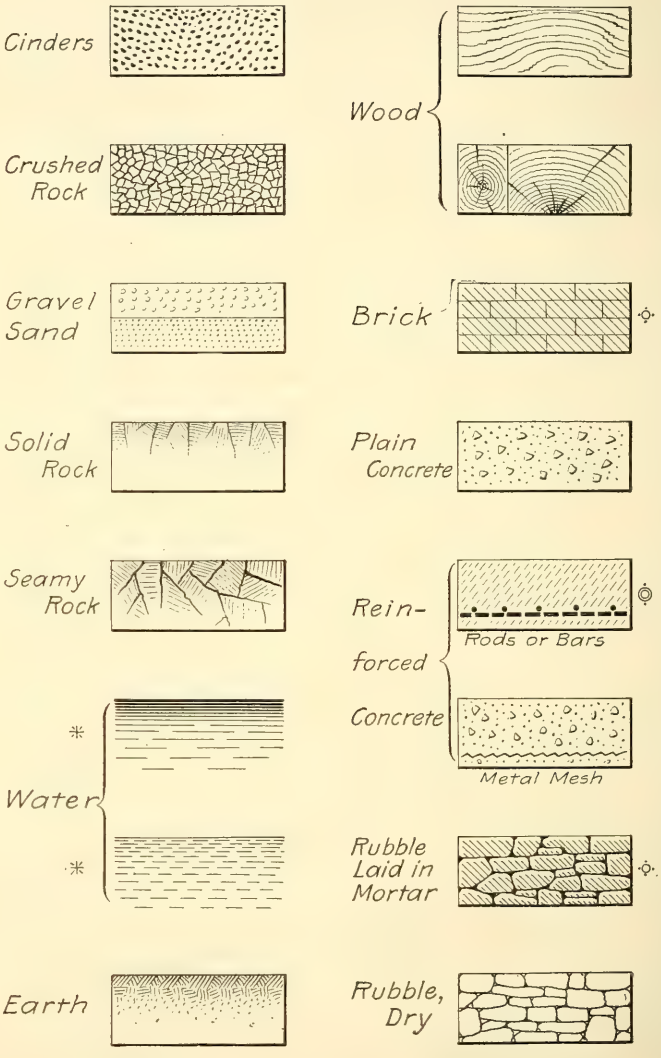
Graphic Scales



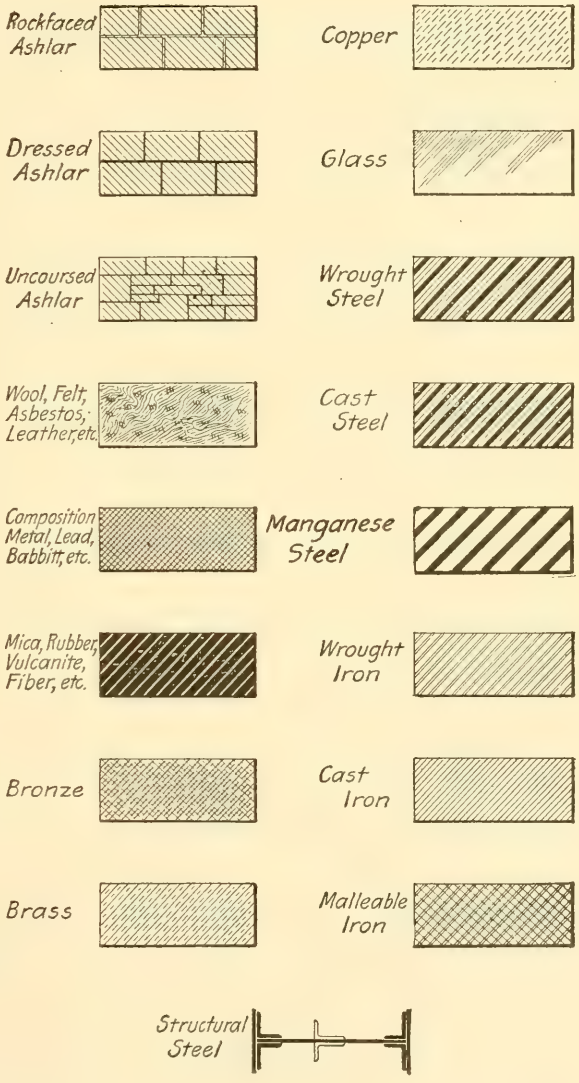
Boom Crane

Gas Container

STANDARD SECTIONS.



STANDARD SECTIONS.



A—BRIDGE RIVETS.

Shop. Field.

Two Full Heads.

Countersunk and chipped, far side.

Countersunk and chipped, near side

Countersunk and chipped, both sides.

Far Side. Near Side. Both Sides.

Countersunk and not chipped

Flattened to ¼-in. high for ½-in and ⅝-in rivets.

Flattened to ⅜-in. high for ¾-in., ⅞-in. and 1-in. rivets.

B—STRESSES.

\+ Tension.

— Compression.

SEC. WM 4A — RECOMMENDED DESIGNS FOR JOINT PLATES FOR SEVEN INCH GIRDER GROOVED AND GUARD RAILS

Your Committee recommends that the dimension one (1) inch be inserted as indicating thickness of plate on head side of rail at centre of bolt hole.*

SEC. WR 1A — T-RAILS FOR USED IN PAVED STREETS*

Your Committee recommends that the title of this subject be changed to read: "Plain Girder Rails for Use in Paved Streets," for the reason that the term T-Rails is often misused.

2. It is also recommended that additions be made to information on previous consideration of the subject. These additions which follow are to be added to first page of Section Wr 1a of Engineering Manual ahead of the present caption "The Use of T-Rail in Paved Streets," which caption shall be changed to "The Use of Plain Girder Rail in Paved Streets."

Proposed RECOMMENDATION	How considered: By	How considered: Action taken	Proceedings	Page reference
T-rail sections for use in paved streets.	Committee on Way Matters.	Progress Report.	1912	597, 614–621
	Committee on Way Matters.	Recommended that subject be continued.	1913	526, 548
	Committee on Way Matters.	Progress report; several conclusions presented.	1914	488–492
	1914 Convention.	Discussion. Report of Committee on Way Matters accepted.	1914	537–542
	Committee on Way Matters.	Several changes suggested, including sub-division into two subjects.	1915	

3(*a*). It is also recommended that the Manual be revised so that there shall be two sections on the subject of Plain Girder Rails, one to be a new section headed "Recommended Designs for Plain Girder Rails" and the other to be headed "Plain Girder Rails for Use in Paved Streets." These sections to contain new or revised matter as hereinafter set forth.

* Formally approved by both the Committee on Standards and the 1915 Convention.

(*b*) Each section shall contain the same information as to previous consideration as now printed with additions as noted in Section 2 above.

4. It is recommended that the subject matter now given in the Manual on T-Rails for Use in Paved Streets be revised to read as herewith set forth.

THE USE OF PLAIN GIRDER RAIL IN PAVED STREETS

The use of plain girder rail for track construction in paved streets is recommended except where the vehicular traffic in congested sections of narrow city streets is largely confined to the pavement area maintained by the railway. This condition exists, as a rule, only in cities of the largest class, and for use in such cases the Committee on Way Matters is of the opinion that the American Electric Railway Association standard grooved girder rails are best adapted.

The selection of plain girder rails for use in paved streets requires the most careful consideration of the type of pavement to be installed and the vehicular traffic to be sustained. Particular care should be taken with respect to the use of the standard section rails in pavements, as it will often be found that the plain girder rails of equal weight are much better adapted to a greater range in types of pavement which may be selected for use therewith.

For use, where the type of pavement will permit, as with waterbound and bituminous macadam, wood, brick, or other shallow block pavements in wide streets having moderate vehicular traffic, three standard rails are recommended. These are shown on drawings marked Fig. 1, Fig. 2 and Fig. 3, in Section — of this Manual and weigh 80, 90 and 100 lb. per yard respectively. Fig. 1 corresponds to the American Railway Association standard 80 lb. rail, while Fig. 2 and 3 correspond to the American Railway Engineering Association standard rails of these weights adopted in 1915. The three types are recommended in order to provide for varying degrees of rail service as may be desired.

For use in light service with deep pavement, a 7 in. plain girder rail, with a 6 in. base, 7/16 in. web and a head 2½ in. by 1-9/32 in., and weighing 80 lb. per yard, as shown in drawing in Section — of Manual, Fig. 4, has been adopted. This section is identical with L. S. Co. Section No. 80–335 and P. S. Co. Section No. 277.

For use in heavy service, in connection with deep block pavement, a plain girder rail 7 in. in height, with 6 in. base 9/16 in. web, and a head 2¾ in. by 1-63/64 in., weighing 91 lb. per yard as shown in drawing in Section — of this Manual, Fig. 5, is recommended. This section is identical with L. S. Co. Section No. 91–375 and P. S. Co. Section No. 282.

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5. It is recommended that Fig. 1, Wr 1a of Manual showing designs for standard section rails be withdrawn and that new drawings showing the 80, 90 and 100 lb. standard sections, separately, be substituted. These to be marked Fig. 1, Fig 2, Fig. 3 to show designs as per

drawings so numbered and attached hereto. Fig. 1 to show standard 80 lb. American Railway Association "A" rail, and Fig. 2 and 3 to show respectively 90 lb. and 100 lb. rails as adopted by the American Railway Engineering Association in 1915. These drawings to follow subject matter of new section.

6. It is recommended that the present Recommended Design for 7-in. 80 lb. plain girder rail (Fig. 3, Wr 1a of Manual) be retained, and words "Section B" eliminated. The caption to be changed to read Recommended Design for 7-in. 80 lbs. Plain Girder Rail for Light Service in Paved Streets.

7. It is recommended that the design for a 7-in. 100 lb. T.-Rail (Fig. 2, Wr 1a of Manual) be withdrawn as not being in demand; it never having been rolled. Substitute therefor a 7-in. 91 lb. plain girder rail (P. S. Co. Section 282 — L. S. Co. Section 91–375), as shown on drawing marked Fig. 5, herewith.

NOTE.— Manufacturer's information shows that this rail section has a very wide use and is the most popular of the three 7-in. plain girder rails, weighing 80, 91 and 93 lb now in use.

8. It is recommended that the subject matter for the proposed new section of the Manual on Recommended Designs for Plain Girder Rails shall be worded as below and the drawings of Recommended Designs for the rails marked Fig. 1 to 5, inclusive, above referred to, shall be inserted in this new section, following the printed matter.

RECOMMENDED DESIGNS FOR PLAIN GIRDER RAIL

1. For general track construction in private right of way and for use in streets where the type of pavement will permit as in macadam or other shallow pavement, standard section rails weighing not less than 80 lb. per yard are to be preferred and three designs, weighing 80, 90 and 100 lb. per yard respectively, as shown in drawings herewith marked Fig. 1, Fig. 2 and Fig. 3, are the Recommended Designs.

2. For track construction for light service, in connection with deep block pavement, a 7 in. plain girder rail having a 6 in. base, 7/16 in. web, 2½ in. by 1-9/32 in. head and weighing 80 lb. per yard, as shown in the drawing marked Fig. 4, has been adopted as a Recommended Design.

NOTE.— This section is identical with L. S. Co. 80–335 and P. S. Co. 277.

3. For track construction for heavy service in conjunction with deep block pavement, a 7 in. plain girder rail having a 6 in. base, 9/16 in. web, 2¾ in. by 1-19/64 in. head and weighing 91 lb. per yard, as shown in drawing herewith marked Fig. 5 is a Recommended Design.

NOTE.— This section is identical with L. S. Co. 91–375 and P. S. Co. 282.

4. For track construction for heavy service in connection with deep block pavement in the congested sections of narrow city streets where the vehicular traffic is largely confined to the pavement area to be maintained by the railway, which conditions exist, as a rule, only in cities of the largest class, your Committee recommends the use of the Association Standard Grooved Girder Rails, as shown in Sections Wr 3b and Wr 4b of this Manual.

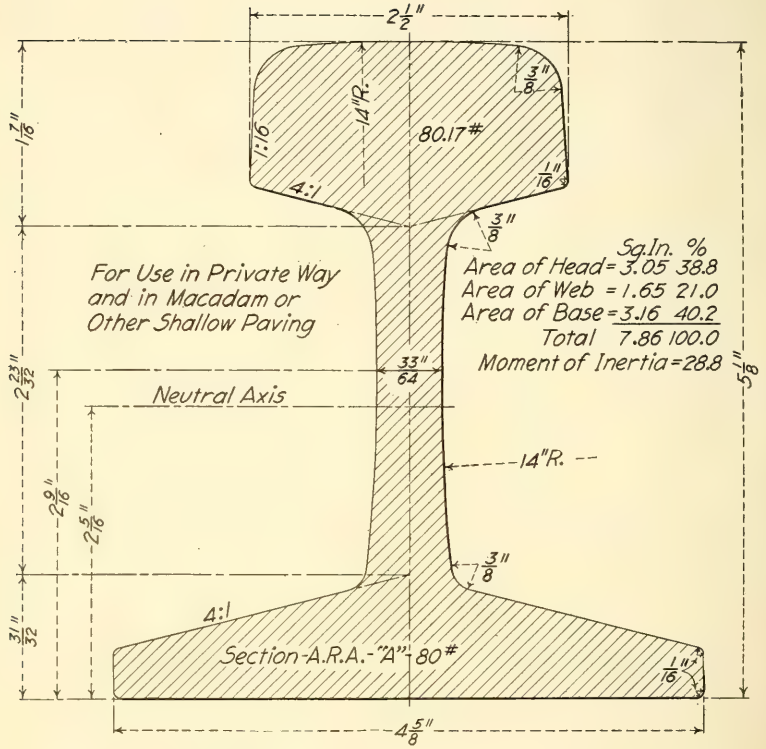

FIG. 1. 80-LB. STANDARD SECTION RAIL FOR USE IN PRIVATE WAY AND IN MACADAM OR OTHER SHALLOW PAVING.
(Submitted for adoption as a Recommended Design and to supersede Fig. 1, shown in Wr 1a, Engineering Manual.)

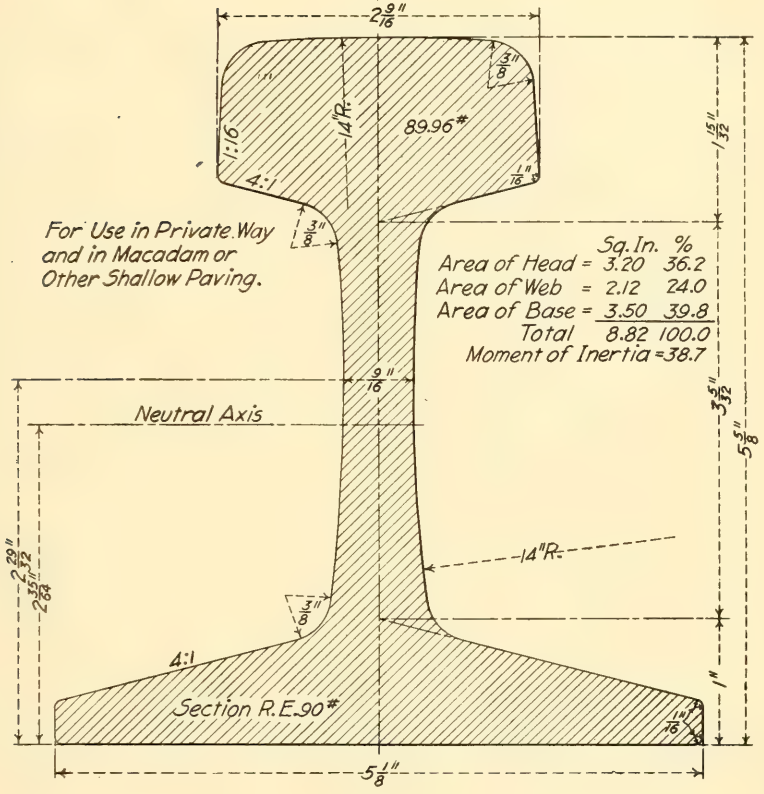

FIG. 2. 90-LB. STANDARD SECTION RAIL FOR USE IN PRIVATE WAY AND IN MACADAM OR OTHER SHALLOW PAVING.
(Submitted for adoption as a Recommended Design to supersede Fig. 1, shown in Wr 1a, Engineering Manual.)

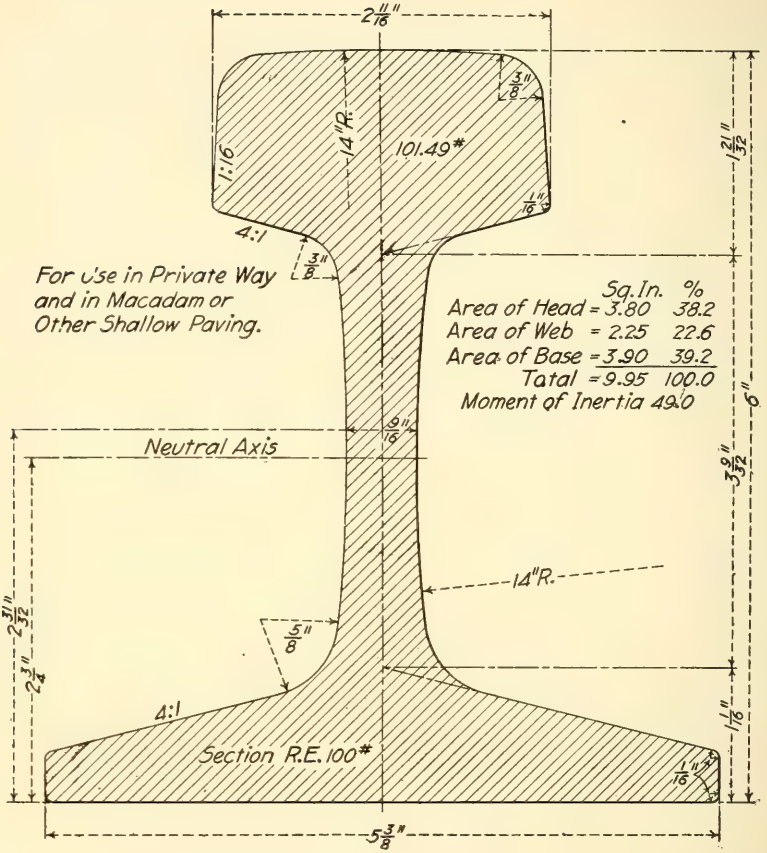

FIG. 3. 100 LB. STANDARD SECTION RAIL FOR USE IN PRIVATE WAY AND IN MACADAM OR OTHER SHALLOW PAVING.
(Submitted for adoption as a Recommended Design to supersede Fig. 1, shown in Wr. 1a, Engineering Manual.)

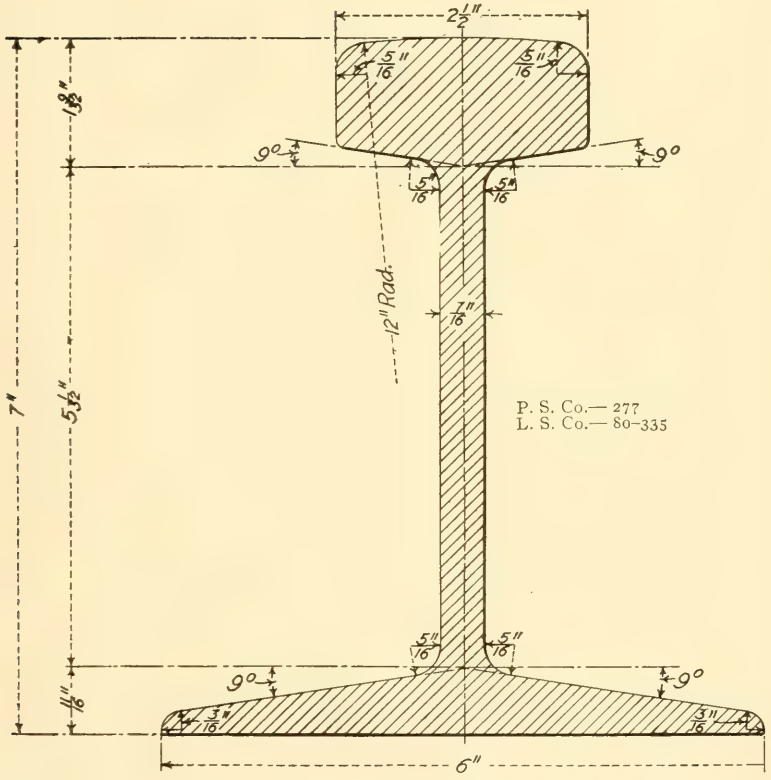

FIG. 4. RECOMMENDED DESIGN OF 7-IN. 80 LB. PLAIN GIRDER RAIL FOR LIGHT SERVICE IN PAVED STREETS.

(Note.— This is same as shown in Fig. 3, Wr 1a of Engineering Manual.)

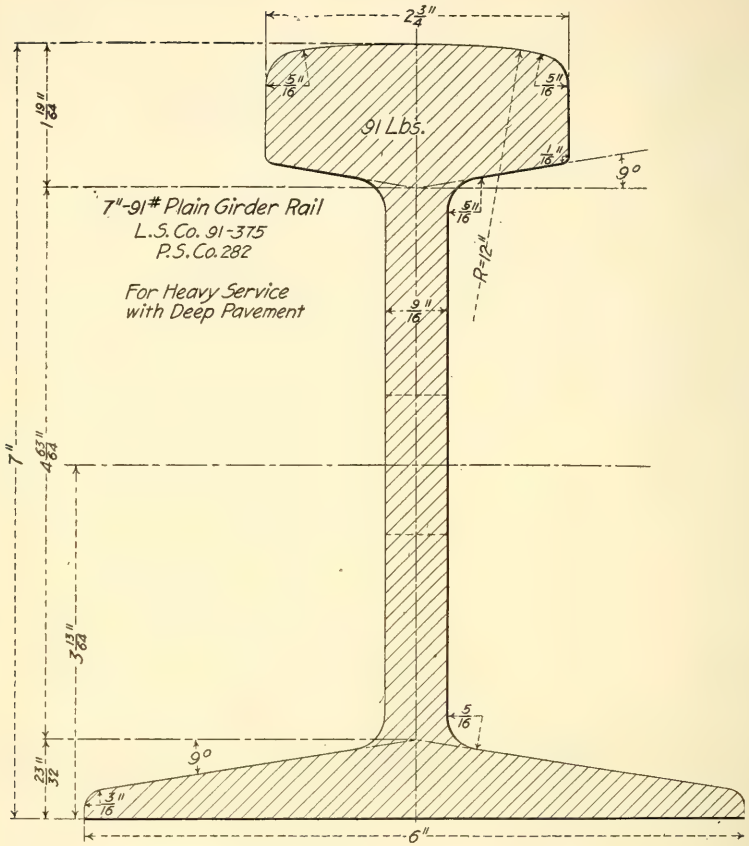

FIG. 5. 7-IN. 91 LB. PLAIN GIRDER RAIL FOR HEAVY SERVICE WITH DEEP PAVEMENT. (SEE FIG. 6, PAGE 26, FOR SUGGESTED JOINT PLATE DESIGN.)

(Submitted for adoption as a Recommended Design to supersede Section "A" 7-in. 100 lb. T-Rail, now shown in Engineering Manual.)

SEC. WS 1A — RECOMMENDED DESIGN OF LAYOUTS FOR SWITCHES, MATES AND FROGS.

Our attention has been called to these layouts, with reference to their being in need of revision.

Your Committee therefore recommends that the ensuing Committee be assigned the task of investigating and reporting on this subject.

Respectfully submitted,

H. F. MERKER,
E. P. ROUNDEY,
E. H. BERRY,
C. W. GENNET, JR.,
E. M. HAAS,
W. F. GRAVES,
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Committee on Way Matters.

APPENDIX B

TYPES OF TRACK CONSTRUCTION COMMONLY USED IN PAVED STREETS

NATURAL SOIL CONSTRUCTION

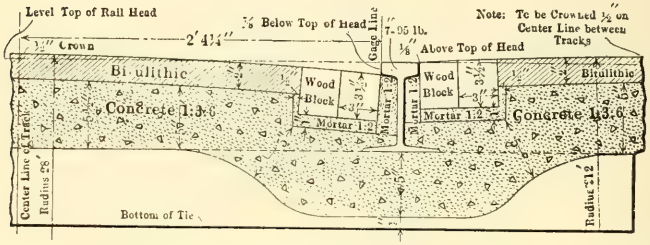

FIG. 1. CONNECTICUT CO.— BITULITHIC CONSTRUCTION, GREENWICH.

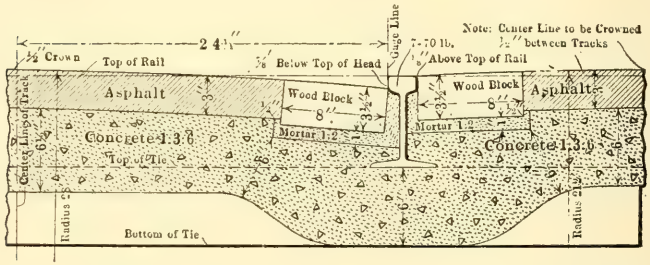

FIG. 2. CONNECTICUT CO.— ASPHALT AND WOOD BLOCK CONSTRUCTION, NEW BRITAIN.

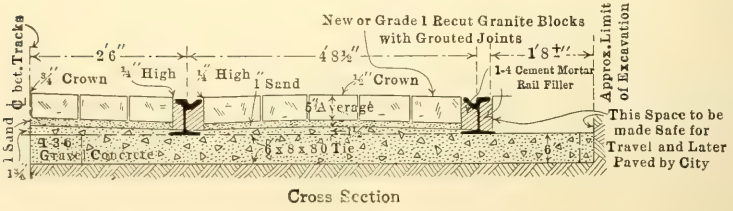

FIG. 3. STANDARD CONSTRUCTION, BROOKLYN.

APPENDIX A

COLLECTION OF STATISTICS AND OPINIONS BY THE UNITED RAILWAYS & ELECTRIC CO. OF BALTIMORE REGARDING THE PROPER FOUNDATION FOR TRACKS IN PAVED STREETS

JANUARY, 1915

(To accompany report of Committee on Way Matters on proper foundation for tracks in paved streets.)

Population		City	The character of foundation in paved streets under tracks with overhead trolley corresponds to types shown on page 478 of 1914 Proceedings, A. E. R. E. A., as follows: Type 2 — Col. 1 Natural soil under ties, no ballast	Type 4 — Col. 2 Gravel or broken stone under ties	Type 4 — Col. 3 Any foundation other than those mentioned	Type 3 — Col. 4 Concrete beam construction	Type 5 — Col. 5 Any modification of concrete beam	Type 5 — Col. 6 Solid concrete under ties	Type 6 — Col. 7 Concrete slab-sub-ballast construction	Character of soil See note. (Number refers to class number)	Concrete types abandoned (Number refers to column number)	What are city's requirements as to foundation (Number refers to column number)	Type recommended for Baltimore	Remarks
			Col. 1	*Col. 2*	*Col. 3*	*Col. 4*	*Col. 5*	*Col. 6*	*Col. 7*					
			Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*					
237,194	1	Seattle	0	0	0	5 '03	0	*108 '95	5 '09	75% 1 25% 2	4	None	Solid concrete.	
373,857	2	Milwaukee	7	*93 '12	..			56 '96		2	6	None	Broken stone rolled	"We have abandoned the use of concrete ballast as it has not proved satisfactory."
533,905	3	Pittsburgh	0	*595 '95	0 Clam shells '02	0	0	1 '12		3	0	2	Broken stone rolled	Concrete tried for test purposes only.
339,075	4	New Orleans		*125 6	*31			*13 6 '12		3	0		Broken stone rolled	Concrete was adopted for certain locations owing to very poor soil
319,198	5	Los Angeles	20	*329 4 '00	Br. stone grouted *25 9 '11			*9 7 '10		2	0	3–6	Stone if drained	"Our city requirements will be No. 2 next."
104,402	6	Spokane		*23 '03 '10		'0 5				2	0	None	Stone or gravel	
331,069	7	Washington, D. C. (C. T. Co.)		*10 8 '02						2	0	None	Stone or gravel	Mostly all underground conduit system
670,585	8	Boston (Boston El. Ry. and neighboring cities)	255 '01	*7 4		4 7		1.5	1 4 4	2	6–7	7	Natural soil rolled	"We are now favoring broken stone instead of concrete."
145,986	9	Worcester	*75.							1		None	Natural soil	
124,096	10	Omaha		*39 6 '03	Cinders *65.7			1.2 '07	*1 5 '07	1	0	2	Broken stone rolled	"We have had considerable trouble with Type 5."
207,214	11	Portland, Ore.		*131.6 '07		2 4 '02 '03				Varies	0	7	Broken stone.	
416,912	12	San Francisco	75 '02	*145						2	0	None	Broken stone	The Municipal railway has adopted broken stone ballast
218,149	13	Rochester	5 1	*27 2		2 1	Steel ties 14.9	48 1		2	4–5–6	None	Broken stone drained	
2,185,283	14	Chicago (C. S. Lines)	Prior to '07 150	*347 '07 '08				*420 '07 '08		Varies	0	2–6	Broken stone	"Stone ballast has proven more satisfactory and paving has held up better than any other type we have laid."
213,381	15	Denver (D. T. Co.)		*40 '90						1	0	None	Best determined by engineer on the ground	Some concrete types experimented with. Not found successful.
233,650	16	Indianapolis		*96 4 '93	Cinders	2 5 '00 '06			*41 1 '08	1	4	None	Broken stone	Concrete used for very heavy service
100,253 76,813	17	Albany and Troy	3 3	*97.2 '93 '06 '01	1.7			*6 2 '93 '02		2	4	None	Broken stone	"Stone ballast type we are now making our standard."
560,663	18	Cleveland	48 3	122.3				*113.5 '05		1	4	None	Concrete-steel ties	
687,029	19	St. Louis		*88.		9		*230 '03		2	4	None		
131,105	20	Memphis		*87. '05	Cinders *21.			30 '08		Good if kept dry		None	Broken stone	"Solid concrete construction has not proven satisfactory; making a very noisy track and tending to cause corrugation owing to its rigidity."
301,408 214,744	21	Minneapolis-St. Paul	273	*62. '00		13				1	4	None	Broken stone rolled.	
112,571	22	Grand Rapids		*67.						1	0	2	Sand and gravel.	
423,715	23	Buffalo	8.2 '93	62 9 '97 '10 '06		32 9	'97	75.2 '0	*40 8 '12	2	4–6	7	Broken stone if it will rigidly support.	
137,249	24	Syracuse		*80				12 5 '07		1	6	None	Broken stone if drained.	
248,381	25	Kansas City, Mo	'94	*250		30.		*3 '13		2	4	None	Concrete, heavy traffic, stone, light traffic	"We have 190 miles of track on stone ballast in improved paving that has proven satisfactory."
1,634,351	26	Brooklyn	*486 8				Steel ties 10 3 '07			1	5	1	Soil or stone.	
363,591	27	Cincinnati (C. T. Co.)		*50 4 '97 '07		1 8 '01		*145 2 '97 '07		2	4	None	No recommendation.	
181,511	28	Columbus		70 7		28 1 '00		*11 2	*0 7 14	2	4	6	Concrete slab.	
224,326	29	Providence, R. I.	64 5	*7 7 '12		1 3 '02		*17 5 '07		1	*4	2–6	Broken stone	No. 6 is being used owing to city's requirements.
223,928	30	Louisville		*29 5 '97	Concrete Louisville cement 61 5 '00	5		*46 '08		2	3–4	None	No recommendation	"Solid concrete tends to produce corrugation. We are now trying broken stone."
347,469	31	Newark, N. J. (P. S. Ry.)†											Broken stone	"A few years ago many roads laid their tracks with concrete foundations. Now some of them are going back to broken stone because they find it just as satisfactory and a good deal cheaper, gives excellent drainage, is easier on rolling stock and may be installed under traffic."
267,779	32	Jersey City (P. S. Ry.)†											Broken stone	
127,628	33	Richmond‡								6	6–2	Broken stone	For failure of solid concrete foundation in Richmond, see, *Electric Railway Journal* — Vol. 44 No. 3. p. 133 — July 18, 1914.	
1,549,008	34	Philadelphia‡					17.2 '03 '06						No recommendation.	With the exception of 17.2 miles of concrete foundation all surface tracks are built on gravel or natural soil.
154,839	35	Atlanta	22 2	*151 5 '01	Br. stone grouted *5 8 '10	1.1		*2 9 '07		1	4	3 4 or 6	Broken stone.	
132,685	36	Birmingham‡											No recommendation.	
168,497	37	Toledo	18.5	36 7				34 8	*8 5 '12	3	6	None	Natural soil	
110,364	38	Nashville		*7 '03	Concrete under center of ties *3 '12		'14 *5 5 '13	1 '03	Under sp. wk. *'14	1	5–6	None	Concrete beam construction	
465,766	39	Detroit		27 3 '05					*149.5 '08	2	4	None	Concrete slab subballast construction.	
133,605	40	New Haven (The Conn. Co.)	*76 2	*4 9 '07	Br. stone grouted	3 1 '02			*10 6 '07	Between 1–2	4	None	Natural soil or broken stone	The Connecticut Co. operates in several cities with different soils, and different conditions.
558,485	41	Baltimore	130	*99 8	*5 3							2–3		We believe that concrete foundation in any form is unsatisfactory.
		Total for the 36 cities furnishing statistics	1718 1	3415 9	220.9	142.5	47.9	1,381.9	403 4	Grand total — 7,330 6 miles				

NOTE.— The figures after mileages indicate the year in which the type was adopted.
* Represents types that are considered standard and are still being used.
† No statistics furnished (Broken stone standard on P. S. Ry.)
‡ No statistics furnished.

CLASSIFICATION OF SOILS

Class 1 — Soil with good and sufficient bearing power throughout; no water stays near foundations.
Class 2 — Soil with good bearing power in certain sections of the city, bad in other sections.
Class 3 — Soil generally poor; holds water, and has not sufficient bearing power to sustain the loads.

PLAIN BALLASTED CONSTRUCTION

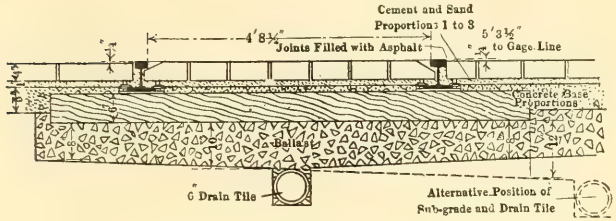

FIG. 4. STANDARD CONSTRUCTION, KANSAS CITY.

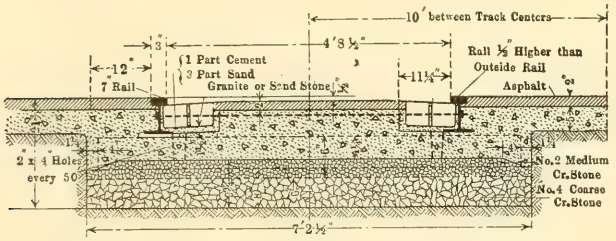

FIG. 5. STANDARD CONSTRUCTION, MILWAUKEE.

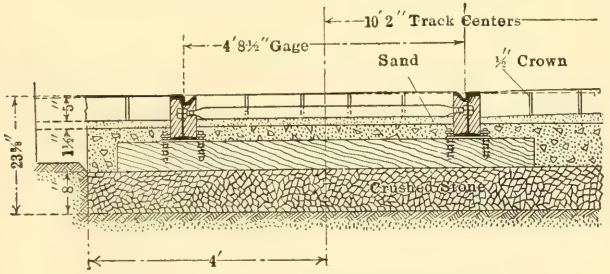

FIG. 6. BALLAST CONSTRUCTION, CHICAGO.

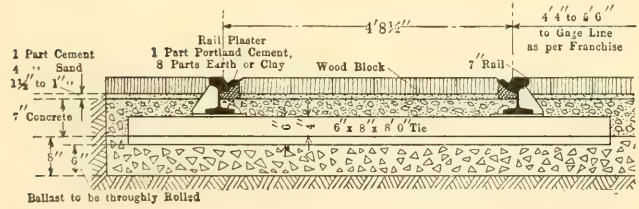

FIG. 7. STANDARD CONSTRUCTION, NEWARK, N. J.

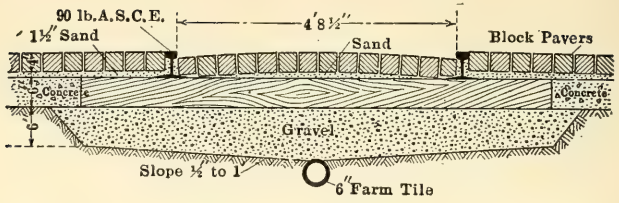

FIG. 8. STANDARD OF ILLINOIS TRACTION SYSTEM.

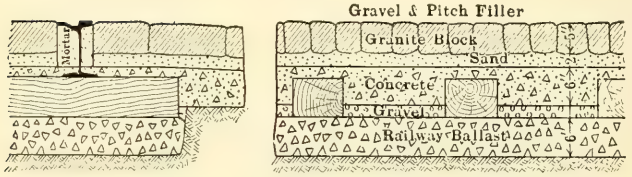

FIG. 9. TYPES OF TRACK CONSTRUCTION AND PAVING USED IN BALTIMORE.

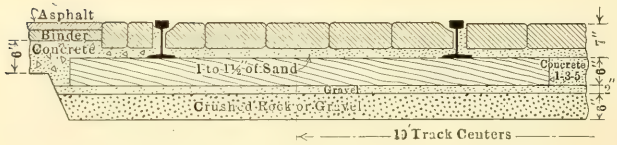

FIG. 10. STANDARD CONSTRUCTION, MINNEAPOLIS.

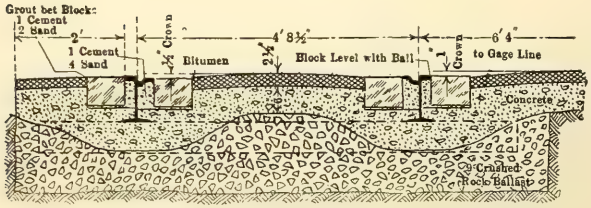

FIG. 11. STANDARD CONSTRUCTION, SAN FRANCISCO.

CONCRETE SLAB SUB-BALLAST CONSTRUCTION

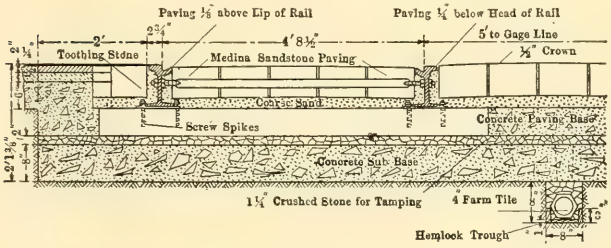

FIG. 12. STANDARD CONSTRUCTION, BUFFALO.

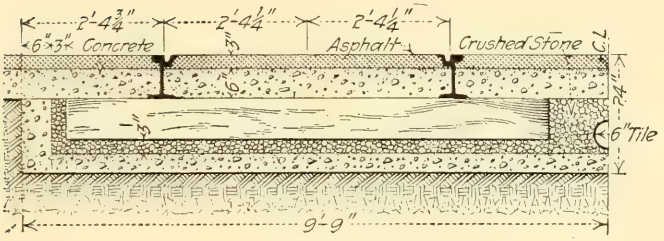

FIG. 13. STANDARD PRACTICE IN HARTFORD, CONN.

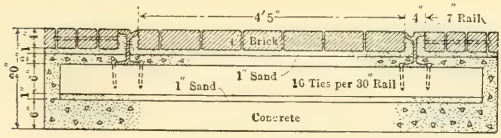

FIG. 14. STANDARD CONSTRUCTION, DETROIT.

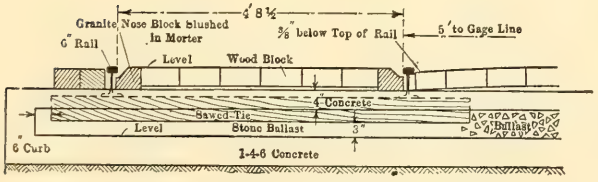

FIG. 15. STANDARD CONSTRUCTION, TOLEDO.

SOLID CONCRETE CONSTRUCTION

USING WOOD TIES

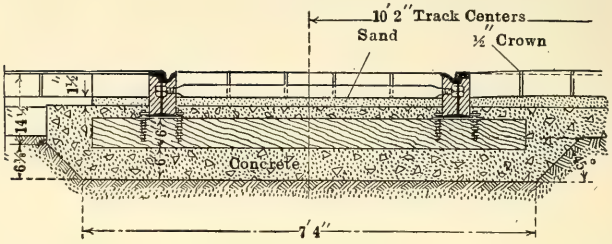

FIG. 16. CONCRETE CONSTRUCTION, CHICAGO.

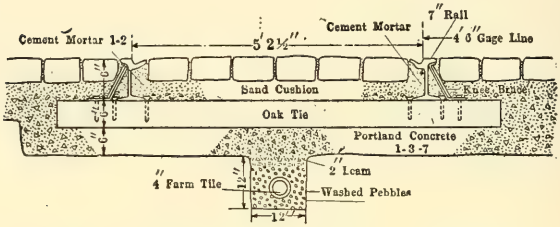

FIG. 17. STANDARD CONSTRUCTION, CINCINNATI.

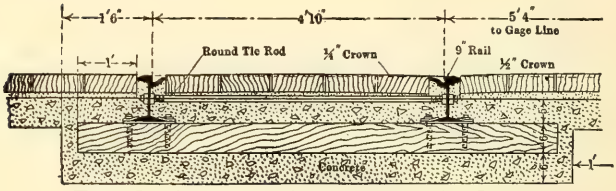

FIG. 18. STANDARD CONSTRUCTION, ST. LOUIS.

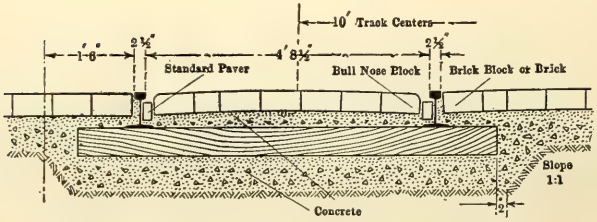

FIG. 19. STANDARD CONSTRUCTION, SEATTLE.

USING STEEL TIES

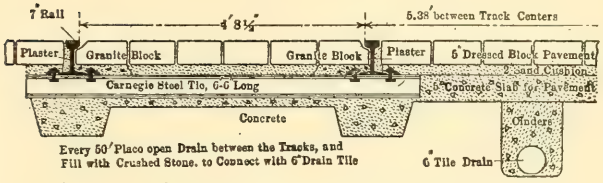

FIG. 20. STANDARD CONSTRUCTION, CLEVELAND.

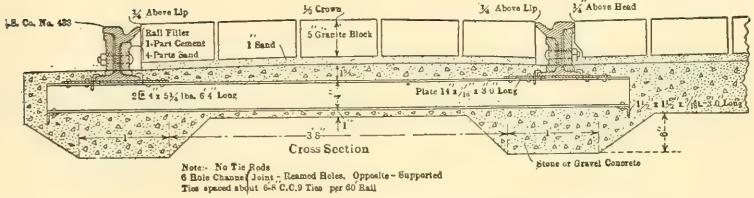

FIG. 21. TWIN STEEL TIE CONSTRUCTION, BROOKLYN.
(Experimental; not standard.)

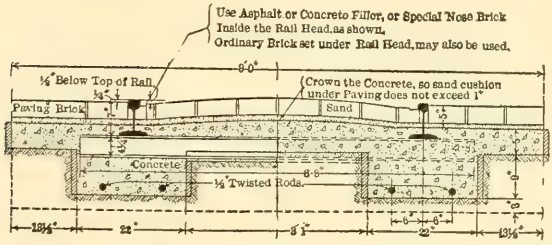

FIG. 22. STEEL TIE CONSTRUCTION, SPRINGFIELD, MO.

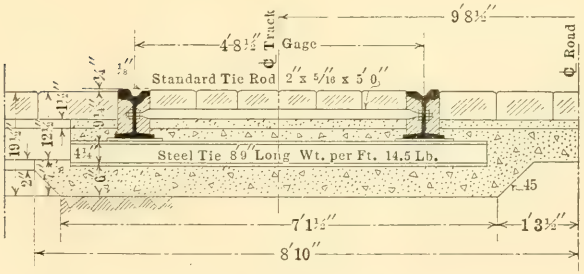

FIG. 23. STEEL TIE CONSTRUCTION, CHICAGO.

APPENDIX E

BIBLIOGRAPHY ON STREET PAVEMENTS

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APPENDIX C

SUMMARY OF TRAFFIC COUNTS 1915. 5.00 A. M. TO 7.00 P. M

City	Street	Location	General Vehicular Traffic. Daily: Effective traffic width	Number of days averaged	Total number	Number per yard of width	Total tons	Tons per yard of width	Kind of paving	Condition of paving	Traffic, Etc., on Track Space Daily: Kind of rail	Number of cars	Number of vehicles	Single or double track	Kind of paving	Condition of paving
			Yards										*Per cent.*			
Montreal	Craig	St. Urbain and Cote	16 66	4	2,860	175 2	4,044	247 66	Granite	Old and very rough	7″ T	1,999	0 94	Double	Granite	Rutted and very uneven.
*Syracuse	West Fayette	South West and South Franklyn	11 66	4	1,985	170 4	2,939	251.30	Asphalt	New and even	T	384	93 11	Double	Medina	New and even.
*Syracuse	West Onondaga	South Salina and South Clinton	13.0	4	2,939	220.9	4,623	354 90	Asphalt	Old and very rough	Tram girder	312	75 09	Double	Brick	Rutted, as good as outside.
*Syracuse	South Warren	East Fayette and East Jefferson	11 66	4	1,616	140 0	2,565	219 50	Asphalt	Old and very rough	Groove girder	780	99 29	Double	Brick	Rutted; as good as outside.
Cincinnati	Gilbert avenue	Court and East 6th	22 66	4	3,845	172.1	6,497	295.45	Granite	New and even; relaid 1913–14	Groove girder	980	34 35	Double	Granite	New and even.
Washington	M street	Wisconsin and Potomac	16 66	2	2,385	147.2	3,831	236.41	Asphalt	Old and slightly uneven	Groove girder	756	8 22	Double	Scoria	New and slightly uneven.
Washington	14th street	G and F	22 0	2	2,280	103 6	3,785	171.47	Asphalt		7″ Trilby	1,092	1 51	Double	Wood block	Rutted
Washington	Florida avenue	7th and 8th	14 33	2	1,372	96 1	2,141	149 35	Granite	Old and slightly uneven	8″ Trilby	1,232	41 09	Double	Granite	Rutted; better than outside
Washington	9th street	D and E	15.66	2	1,603	102 4	2,471	157.76	Asphalt	Old and slightly uneven	7″ Trilby	700	23 07	Double	Scoria	As good as outside.
Anderson	Meridian	10th and 11th	13 66	3	1,291	94.0	1,901	138 9	Brick	Old and slightly uneven	7″ T	182	10 56	Single	Brick	Better than outside.
Brooklyn	Flushing	Vanderbilt and Clermont	16 0	1	4,234	267.0	6,207	392.0	Granite	New and even	Groove girder	286	42 82	Double	Granite	As good as outside.
Brooklyn	Hamilton	Henry and Luquer	14.0	1	1,162	84 0	1,563	110 0	Granite	New and even.	7″ T	338	57.49	Double	Granite	As good as outside.
Brooklyn	Nostrand	Lexington and Quincy	10.0	1	937	93.0	1,275	128 0	Asphalt	New and even	Groove girder	342	88 90	Double	Granite	As good as outside.
Brooklyn	Fifth	Baltic and Warren	10.0	1	1,293	131.0	1,719	172.0	Asphalt	New and even	Groove girder	544	90 64	Double	Granite	As good as outside.
				Hour	*Per hour*	*Per hour*										
†Chicago	Randolph		15 0	5	297	19 9			Wood block	Good and smooth			38.0			
†Chicago	Madison		14.33	6	157	11.0			Wood block	New and smooth			59 0			
†Chicago	Van Buren		11.50	6	119	10.0			Granite	Old and rough			65 0			
†Chicago	Harrison		11 66	2	268	22.9			Granite	Old and rough			87.0			
†Chicago	Wabash		18.33	10	210	11.5			Asphalt, wood block and granite				42 0			
†Chicago	State		19 75	7 5	231	11 2			Asphalt and granite	Old and rough			39 0			

* Count 12 hours 7 A. M. to 7 P. M.
† Count taken in one-half hour periods on several days.

APPENDIX D

ONE DAY TRAFFIC RECORD

FORM II (REVISED)

APPENDIX D

ONE DAY TRAFFIC RECORD

FORM II (REVISED) — A. E. R. E. A. 1915

City _____ State _____ Day _____ Date _____

Street _____ Between _____ and _____ Weather _____

TRACK SPACE

Width of track space _____ Ft

Single or double track _____

In center or on side _____

Gauge of track _____ Ft _____ In.

Distance center to center of track _____ Ft _____ In.

Type of rail _____

Track foundation _____

_____ Laid _____

Sub-soil _____ Drained _____

Paving foundation _____

Paving at gauge _____

Paving between rails _____

Paving outside rails _____

Kind of filler _____

When laid _____ Repaired _____

State of pavement _____

When noticeable deterioration began _____

In what form _____

ROADWAY

Effective width (if yard less than width curb to curb) _____ Yds

Paving foundation _____

Kind of paving _____

Kind of filler _____

When laid _____

State of pavement _____

Speed of vehicles M. P. H. Horse _____ Motor _____ Cars _____

Number cars per hour. Max _____ Min _____

Average _____ Total 14 hours _____

Number of vehicles per hour Max _____ Min _____

Average _____ Total 14 hrs _____

Number tons per hour. Max _____ Min _____

Average _____ Total 14 hrs _____

Number vehicles per yard per hour _____

Number tons per yard per hour _____

Average percentage of vehicles using track space Number _____

Tons _____

General remarks _____

Between hours	Horse vehicles: 1-horse	2-horse	3 horse	Total horse vehicles	Motor vehicles: Passenger	Truck	Total motor vehicles	Number vehicles using track space	Tons on track space	Number standing vehicles	Number cars
A.M. 5–6											
6–7											
7–8											
8–9											
9–10											
10–11											
11–12											
P.M. 12–1											
1–2											
2–3											
3–4											
4–5											
5–6											
6–7											
Totals											

NOTE 1 horse vehicle Average _____ ton Pass. motors average _____ ton Observers _____

2 " " " _____ " Motor trucks " _____ "

3 " " " _____ "

Checked by _____

Approved _____

5106 b

REPORT OF COMMITTEE ON STANDARDS CONCERNING CERTAIN RECOMMENDATIONS OF THE COMMITTEE ON WAY MATTERS

1914-1915

Recommendation of the Committee on Way Matters:

(*a*) As Recommended Specifications. Specifications for Special Work, as shown on page 478 of this Report. Also, that the work be continued by the ensuing Committee.

Action of Committee on Standards:

Adoption as Recommended Specifications approved.

Recommendation of the Committee on Way Matters:

(*b*) As Recommended Designs. Types of Track Construction Type B — Type C, as shown on pages 470 and 471 of this report.

Action of Committee on Standards:

Approved Type B as Recommended Design. On Type C, action withheld until after Convention.

Recommendation of the Committee on Way Matters:

(*c*) As Recommended Practice. Classification of Soils as shown on page 469 of this report.

Action of Committee on Standards:

Disapproved but to be inserted in Engineering Manual under Miscellaneous Methods and Practices.

Recommendation of the Committee on Way Matters:

(*d*) As Recommended Design. Design — Joint for 7-in. 80 lb. and 7-in. 91 lb. Plain Girder Rails.

Action of Committee on Standards:

Approved as Recommended Design.

Recommendation of the Committee on Way Matters:

(*e*) A: Recommended Design. Drilling for standard Section Rails (A. E. R. A. Standard). Recommended adoption for use with 80, 90 and 100 lb. standard rails.

Action of Committee on Standards:

Approved as Recommended Design.

Recommendation of the Committee on Way Matters:

(*f*) As Recommended Practice. Recommended Symbols for Recording Surveys — Sec. Wm 2a of Engineering Manual. To change title to "Conventional Signs for Recording Surveys" and adopt as Recommended Practice the signs adopted by the I. C. C. with modifications, superseding present Recommendation.

Action of Committee on Standards:

Disapproved and referred to Executive Committee for consideration jointly with committees, in order that all symbols may be included in the revision.

Recommendation of the Committee on Way Matters:

(*g*) Section Wm 4a of Engineering Manual, Specification for Splice Bars and Joint Plates. Recommended dimension of one inch be inserted as indicating thickness of plate on head side of rail at center of bolt hole.

Action of Committee on Standards:

Approved.

Recommendation of the Committee on Way Matters:

(*h*) Section Wr 1a T-Rails for use in Paved Streets. Change title to read: "Plain Girder Rails in Paved Streets", and outline of information. Recommend division into two sections:

1. Designs for Plain Girder Rails.
2. Plain Girder Rails for Use in Paved Streets.

That the subject matter now given in Engineering Manual on T.-Rails for use in paved streets be revised.

Revision submitted.

That designs of Standard Section Rails be made into three separate parts — 80, 90 and 100 lb. sections. These drawings to follow subject matter of new section.

Present Recommended Design for 7-in. 80 lb. plain girder rail to be retained.

That 7 in 100 lb. plain girder rail section be withdrawn, there being no demand, and a 7-in. 91 lb. plain girder (P. S. Co. 282 or L. S. Co. 91–375) be substituted.

Action of Committee on Standards:

Approved.

Respectfully submitted,

C. H. Clark,
J. W. Welsh,
C. F. Bedwell,
C. S. Kimball,
A. S. Richey,
E. R. Hill,
W. G. Gove,
J. H. Hanna,
F. R. Phillips,
W. H. Sawyer,
E. B. Katte,
Martin Schreiber, *Vice-Chairman,*
H. H. Adams, *Chairman,*
Committee on Standards.

PRESIDENT CRECELIUS:— As stated before, these reports have been distributed to the members for some considerable time, and it is presumed that you have all read them. You are therefore at liberty to proceed at once into the discussion of this subject.

Discussion of Report of Committee on Way Matters

W. D. CHAMBERLAIN:— I do not know that I have very much to say on this subject. I have read the report, and find there are many features about it I agree with. There is one feature I do not approve, and that is the T-rail in paved streets. The T-rail has its place, like all other rails, but I favor the high-girder or Trilby rail on account of its strength and the number of bolts in the joint. The T-rail seems to be in great favor in recent years, and there is no question that it has its good qualities. My preference, however, is for a 9-inch girder or Trilby rail, with a sufficient number of bolts to make a good strong joint, and not have any tendency to deflect under the load or cup at the joints. Our experience in the last six years with 9-in., 106-lb. girder, or Trilby rail, is that it has given good satisfaction, and the majority of the joints are today, after several years of use, in perfect condition. The experience I have had with the T-rail has been with the 8-inch rail mostly, and although in my opinion it is a good rail, it is not as good as the 9-inch girder rail for heavy traffic in paved streets. We have heavy cars running under short headway on the streets where our 7 and 9-inch rail is used.

A. E. HARVEY:— I have not had an opportunity to study this report as thoroughly as I might desire, but in regard to the type of track construction referred to here, I cannot but concur with the report of the Committee. I believe that the type of construction recommended is something that will give good satisfaction. Our experience in Kansas City along this line has justified this type of construction. In fact, it is almost identical with the work that we are doing in the reconstruction of our old tracks.

One other advantageous point about this type of construction to which I wish to refer is the manner of drainage. I think

that everybody will agree that drainage is proper and necessary, but I fear that there are a great many people who are in the habit of building tracks without providing for this feature.

In regard to the second type of construction in which a concrete slab is used and a dry mixture placed under the ties, although I have had no actual experience with just this type, it occurs to me that there might be some danger of the collection of moisture in the space between the tie and the concrete slab that would result, in the northern climates, in more or less damage to the pavement and the track.

I notice the matter of vehicular traffic is touched on, and I think that will have an important bearing on the type of power used in the future, particularly in regard to the shape and width of the flange-ways. I do not believe that we need to take the extreme care that has been taken in the past to keep a narrow flange-way, but that we can afford to make a broad flange-way adjacent to the rail, which rubber tires will go over easily, and at the same time afford an opportunity for any obstruction in the track, such as dirt or snow, to be flanged back by the wheels themselves. I think that that type of construction would tend to reduce a great many of our troubles in the winter time.

In the matter of pavement I notice that brick pavement is put fourth in the list. I am not so sure but what this type of pavement should be considered in advance of either the sandstone or the wood block. It has certainly given good satisfaction in many places, and I do not believe there is any type of pavement where such good results can be shown in repairs as you can get with brick. A smaller gang of men and a fewer different kinds of material can repair more pavement in the track paved with brick than with almost any other type.

As to the Specification for Special Work, I am not so sure that this matter specifying the percentage of the various elements in the manganese should be incorporated in the specifications, for the reason that in the first paragraph the manufacturer is told definitely what he shall put in. Under the paragraph " Physical Qualities " he is told just what that material must do. If he can determine the results shown

under (*b*) by some other composition, it seems to me that it is a matter for the manufacturer to determine. Certainly, we do not care just what he puts in, so long as we get the results, and in specifying definitely as to the elements, the company may be specifying something that is inconsistent. That same observation applies to other paragraphs in that part of the report relating to the "Specifications for Special Work." It will also apply to cast steel for track castings.

There is one matter in connection with this Recommended Design for Joints for 7-inch Rail to which I desire to refer. It is a question whether or not the section shown will stand the strains that may be imposed upon it where the high grade bolts are used. I think that is a matter that should be taken into consideration. I myself have had some trouble along that line, by using bolts of high elastic limit, which, in some cases, have buckled the plates.

I do not know of any other details in regard to this report that I care to touch upon, except possibly the matter of standardization, particularly of special work design. I think that the work of standardizing those matters should be carried on more extensively and I believe that the Association should do some work in determining standards as to lay-outs, radii of curves, length of pieces, etc., so that the pattern cost in special work might be reduced. It is my opinion that the companies are paying a great deal of money on account of lack of standardization along this line. I have had that matter brought home to me in one or two cases where manufacturers in bidding upon special work have given a price for the first casting and a price for all castings thereafter. That is a proposition that one does not ordinarily receive. I think that the difference in price would be a surprise to a great many. I see no reason why standards of this kind should not be adopted, and in the end we could have switch pieces and frogs of uniform length, and interchangeable, and have matters in such shape that the companies could probably save anywhere from 15 to 25 per cent by our standard work.

PRESIDENT CRECELIUS:— The question of steel and wood ties has been raised, and I wonder if you will enter into the discussion, Mr. Kupfer.

C. A. KUPFER:— Only to say, so far as we are concerned, that we have been looking for a successful substitute for the wooden tie and we are still looking for it.

J. M. YOUNT:— Personally I am very pleased to see this good construction work recommended. While I do not know much about track work, it looks good to me from the standpoint of the mechanical department. The special machine shop, otherwise known as switch and frog shop is under my jurisdiction, and of course, I was surprised when Mr. Legare and Mr. Chamberlain did not tell you how things should be done, as they have told me a lot.

I will say the types of track construction shown are of good design, and the sooner we get work of this kind into use, the better it will be for the rolling stock. I know of one line in San Francisco that cost us $100 per month for wrecking, replacing cars on track alone. The damage done equipment must have been considerable. After this line was reconstructed, the wrecking was practically eliminated and a considerable saving was shown on our maintenance sheet. I cannot understand why Mr. Legare and Mr. Chamberlain have nothing to say on this subject because I know they are doing good work here, and the result of their work is shown on costs of all equipment in my charge.

B. P. LEGARE:— I have nothing to say on the report, because I have not actually read it through. Mr. Yount said that it previously cost several hundred dollars a month for damages to the cars, because of the track, but only about $3 now. It should not have cost anything. There must have been something wrong with the equipment.

C. H. CLARK:— The track looks so good around here I wish you would tell us what the construction is.

B. P. LEGARE:— The construction is very much like the construction shown in Type B, except that our weight in the Trilby rail is 106 lbs. We have anywhere from 81 to 141 lbs., but 106 lb. for the last six years has been our standard. The Type B is very much like it, except that we do not drain. That is, we only drain in certain localities, two or three places in the city, where it is necessary. We use nine inches of crushed rock under the ties, mostly in sandy soil and the water does not

collect. We do not use concrete base between the tracks, except under the pavement. According to this plan the concrete is level with the ties and must be 10 or 12 inches thick. We use only 8 inches.

As to the kind of proper paving: we have tried brick paving, but so far the results have been very poor, partly due to the quality of the brick on the Coast — it is not the same as they have in the Middle Western states. We have used some Seattle brick, which is supposed to be very fine, but with the same results. We have tried brick along the rail, as headers, in asphalt streets. These bricks have worn out to a great extent, and we have gone back to the basalt blocks, Belgian blocks, only a little harder. The blocks are 8 in. x 4 in. x 6 to 7 in. That is one reason, also, why we prefer the extra height in the rail. In the 7-inch rail we get very little foundation under the header blocks over the tie. The block will virtually rest on the tie, the least little movement of the rail works the blocks loose, and in a short time they pump up. With the 9-inch rail, you have 2 inches of concrete over the tie and under the block.

The principal reason why the 9-inch rail is preferred is because we do not consider we can get a proper joint with a 7-inch rail as it is not possible to get enough bolts in it; you have only one line of bolts, instead of a double line of bolts. So far we have not had the success with the 7-inch rail that we have had with the 9-inch rail.

As to general recommendations of the report, I can only say I agree with these thoroughly. I have nothing to say directly in criticism. If any one wants to ask any questions regarding our local practice, I will be glad to answer them.

E. M. Boggs:— My work during recent years having been somewhat far removed from questions of track construction and maintenance (being more concerned with problems relating to teredo-proof piles, hydraulic dredging, etc.), it would seem rather presumptuous for me to attempt to discuss fully this admirable report. However, having had many years experience in the maintenance of tracks laid in city streets, it may be proper for me to say that the importance of underdrainage of tracks is not always fully recognized. Its value

can hardly be over-estimated. Except in very sandy soils, where gravitation can readily overcome capillary attraction and so prevent the accumulation of water under a track, its disposal by drains is one of the most essential features of permanent track construction. In very tight soils the drains are almost as important as the rails themselves. If in such a soil a trench is excavated and filled with crushed rock ballast, but without providing drain-pipes, the construction is simply inviting trouble. Water will be attracted from the surrounding soil to the more porous ballast, the rock — whatever its depth — will be pounded down into the saturated sub-soil, the track will settle and the pavement will be shattered.

Referring to the illustrations on page 471 of the report. Of the two plans for drainage there shown, the one providing a drain under the center of each track is, in my judgment, much preferable to the alternative plan of a single drain between the tracks.

In some localities there will be a well defined movement of the ground-water in one direction across the line: in such places a drain placed outside the ends of ties on the up-hill side of the track may better intercept the water before it reaches the sub-soil below the track. But where the pavement is shattered and most of the water enters the foundation through crevices alongside the rails a drain under the center of each track may be the best.

The point has been raised that in digging trenches across the tracks for connections with main sewer under center line of street, track-drains laid under middle of tracks will be broken and left disjointed. This is doubtless the case, but it is true also that often owing to lack of thoroughness in the original back-filling of a sewer-trench, subsequent settlement will occur to an extent sufficient to wreck a drain-pipe laid on the same line. Moreover, on many of our double-track lines the tracks were laid first and the sewer was put down between them long afterward.

E. J. McIlraith :— In Seattle we have adopted as our standard the solid concrete construction, with no sand or crushed stone cushion under the ties, and I notice that is not given any consideration here, being a less desirable type of

construction. Our type of track construction is shown in the latter part of the report, which, however, omits the drains that we have on a good many of our city streets. Sometimes we have placed them in each of the three locations shown in the committee's report depending on the movement of the water. With the glacial formation of very heavy clay which we have in many locations we have often put drains on the margins of the right-of-way. Our experience has shown us that we cannot get crushed stone or sand or gravel packed solidly under the ties so that all vibration will be eliminated and all vertical movement of the rail eliminated. As soon as you have vertical movement in the rail you have a movement of the pavement. The movement of the pavement means bulging and heaving and as long as you prevent movement of the rail, you prevent deterioration of the pavement. If you have a sand cushion under the ties, which is supposed to provide a cushion, yet supposed to prevent wave motion of the rail, to prevent the hard and solid jolt, you may say, if there is any such resultant action of the cushion effect, I do not see how you can prevent having vibration that will break up the pavement. I have not found in our experience in construction, anything but vibration resulting from that type of construction and if vibration begins it pumps the sand under the ties to the surface of the street, and the sand will pump out through the minute cracks, alongside the ties to the sub-soil, or the rock will crush and crumble and wash away into the cracks and into the soil underneath. We have no frost, and no heaving due to the fact that the moisture gets into the sand underneath. But we do have a pretty wet subsoil, due to the possibility of rain getting in during the entire year. If any seams develop along the ends of the ties, next to the city's paving, the sand under the ties will wash out and pumping follows. If you have the solid construction — we have had brick down nearly twenty years, have reconstructed the track, and we have found that the ties are still there firmly — there has been no pumping resulting, and there have been no detrimental effects noticeable on the cars, but we have the ability to hold our ties solid to the base all the time and the rail can be held solidly. We have not discovered any defects

with solid concrete construction. The ties do not shrink away and do not become loose when the concrete is properly placed and of the proper strength. The solid concrete construction has proved satisfactory to us and has by all means proved more satisfactory than either of the two cushion constructions.

We use 7-inch rail, 80 and 90 lb., and have used some 110-lb. Trilby rail, which was put in at the city's request. We use 140-lb. girder guard on the curves, all 7-inch rail. We are able by means of prompt repairs to joints to keep the track in a reasonably good condition, except in places where we put in some years ago some of the older type of welded joints, which were placed on the old rail, but the chemical composition of the rail would not allow it to stand the heat treatment, and that has given us some trouble on the lighter weights of steel. We have no difficulty in getting setting time for this solid construction on our streets, because we can throw in temporary track on one side of the street or re-route the cars, or build it in short sections with temporary cross-overs of 60-lb. A. S. C. E. rail which we have available for laying on top of the pavement and which we can install in a short time — perhaps in 15 minutes or half an hour and they can be taken up almost as rapidly. That, of course, does not include the time used in sorting the material after it has been delivered on the job, but the time actually needed in tying up the service for installation.

In the report on special work there is one specification, which, it seems to me, should have been included. In all special work the top surface is very carefully ground, very carefully planed, so that there is absolute perfection in the top horizontal surface. But the under side is usually neglected and left rough cast, and it seems to me that is putting the perfection in the wrong place. I was always under the impression, and have not had that opinion changed, that the foundation is the proper place for the greatest amount of care, and the under surface should be more accurately ground than the top surface. There is a hammer blow which will develop quickly from a rough upper surface, but the same amount of vibration will develop through any little roughness on the under surface. I saw some special work at the Exposition that

had a very rough under surface with knobs and unevenness that will not let it lie solidly on the tie. The pressure is going to be greater per square inch at the point of contact, and these small areas will soon settle into the tie leaving a space between the spikes and the special work, so that the piece will rock and work undertraffic. We have had special work delivered to us that was warped so as to leave $\frac{3}{16}$ of an inch on one side between the base of the casting and the tie, while the other side was resting solidly on the tie. It seems to me that is one of the most serious defects special work can have when it is delivered and is one of the most common.

The mates, the report specifies, should have a wearing plate. I think it is decidedly desirable to have cross-overs even on main lines for infrequent use, of built-up construction, using no wearing plate. It seems to me that the best possible construction would be something which gives an unbroken main line rail. To get as nearly as possible an unbroken main line rail, you have either got to have a solid manganese mate, which removes two joints but is expensive when you only use the cross-over in emergency, or the only other alternative would be a built-up type, and I think the latter a preferable type for infrequent service. I do not refer to a turn-out used in regular service, but one which is only in service when a tie-up on the line occurs, and a few cars may be turned back occasionally. Then your material all the way through the main line is the same, and there is no chance of varying wearing quality, no chance of hammer blow developing at either of the joints as with an insert, for the joints are the same as exist in any other part of the track.

President Crecelius:— We have now had considerable discussion from the railroad operators' point of view — the men who have contributed to the discussion so far, I think, without question, have represented the operation of the electric railways. The report carries with it some recommendations which require the approval of this Convention, and in order that you may intelligently act upon these propositions that are submitted, I will now ask the manufacturers present to give us their views on the points involved, and to make the

discussion as brief as possible. I understand they have prepared some matter regarding the recommendations of the committee.

E. B. ENTWISLE:— In the preparation of these specifications I was fortunately invited to take a hand. It has taken about six months to whip them into the shape in which they are presented to you here. They were first prepared by the manufacturers, and about a dozen of the principal manufacturers of special work were invited to criticise them, and then they were presented to the Committee on Way Matters, and representatives from the manufacturers were invited to sit in with the Committee on Way Matters to discuss them. A great many changes were made, and as they are now presented there are only one or two items that we, as manufacturers, cannot agree with.

I will read a letter that has been drafted and forwarded to the Committee asking for certain changes:

September, 1915

To the Committee on Way Matters,

American Electric Railway Engineering Association:

GENTLEMEN: Referring to your "Recommended Specifications for Special Work for Electric Street Railways," as printed in the Advance Paper No. 310, the undersigned manufacturers of special work and Manganese Steel founders, regret to note certain changes in the specification for Manganese Steel from those originally suggested, and they earnestly recommend for your re-consideration, before adoption, the following paragraphs:

Paragraph 1 (a). The last sentence of this paragraph, now reading:

> "When specified a test coupon is to be cast with the casting in the mold, removed and key-marked by the inspector before heat treatment and heat-treated with the special work casting".

should be changed to read:

> "When specified, a test coupon shall be cast from the same heat, separate from the casting, key-marked by the inspector and subjected to equivalent heat-treatment as the special work casting."

Paragraph 1 (b). Now reading:

> "The above mentioned coupon six (6) to ten (10) or twelve (12) inches by one (1) inch by three-quarter (¾) inch shall bend cold on the flat side around a diameter of one (1) inch to an angle of 180 deg. without breaking. The bending may be accomplished by pressure or by blows."

should be changed to read:

"The above mentioned rough cast coupon, from six (6) to twelve (12) inches long by three-quarters (¾) by one-half (½) inch, shall bend cold * * *."

As argument we beg to advance:

First, regarding Paragraph 1 (a):

The heat treating of the small coupon with the large casting will give misleading results, as the large casting requires somewhat different treatment to impart to it the desired qualities, than the light thin coupon. If the two are treated together, one would come out of proper quality while the other would not.

Casting the coupon in the same mould with the casting is not necessary or advisable, as in the necessarily quick manipulation of the mold after casting, the coupon might be injured or lost, or it may not run perfectly. Casting manganese steel coupons or test bars separately, but from the same heat, is universally accepted as good practice.

Second, regarding Paragraph 1 (b):

The size of the test coupon is evidently in error. A bar 1 in. by ¾ in. thick would not bend around a diameter of 1 inch to 180 deg. The regular rule is that the diameter of the bend shall be twice the thickness of the bar, and the usual size of such test bars for manganese steel is ¾ in. by ½ in.

Respectfully submitted,

AMERICAN MANGANESE STEEL CO.,
(Signed) W. S. McKee, *Vice-President.*
BARBOUR-STOCKWELL COMPANY,
(Signed) Fred F. Stockwell, *Treasurer.*
BUDA COMPANY,
(Signed) R. B. Fisher, *Chief Engineer.*
CLEVELAND FROG & CROSSING CO.,
(Signed) G. C. Lucas, *General Manager.*
FALK COMPANY.

With your permission, Mr. President, I would like to touch on Mr. Harvey's remarks with regard to the standardization of patterns. Mr. Harvey suggested that a standardization of patterns was very necessary. We believe in that. You would hardly believe that in one manufacturing concern you could see 250 patterns of tongue switches and mates. It is not only the original cost of the pattern you are paying for, but you are paying for the care of these patterns, for buildings to protect them from the weather, and we are compelled to keep them probably for years, and only one or two castings are

moulded from them. If you can get down to a standard pattern of a standard section you are going to reduce the price of the special work all that Mr. Harvey claims you will. And the same way with the rails. In our catalog, that of The Lorain Steel Co., you will find about 120 rails. You can calculate that every time an engineer changes a section of his rail, and it goes into special work, it will require 40 patterns of tongue switches and mates alone. That means, in the case of 120 rail sections, lying in the yard of the manufacturer, you can multiply the 120 sections by 40, and get some idea of the patterns that are necessary. There are too many. There are too many rail sections and too many standard patterns of tongue switches and mates.

PRESIDENT CRECELIUS:— Mr. Clark, will you sum up this discussion?

C. H. CLARK:— Mr. Chamberlain objected to the T-rail on account of the joints not being as strong as those in grooved girder rail. I am of the opposite view. In the T-rail you have two plates of the same size, a center-bearing rail. In the girder rail you have a side-bearing rail. With the T-rail, with the same amount of material, you would have perhaps 20 or 30 per cent more strength. I was surprised to hear that the objection to the T-rail was with regard to the joint. The objection is generally that you cannot pave against the T-rail. Of course, that is not so. T-rail in the city of Cleveland is now standard, on all streets, regardless of width. We have double track in Cleveland on streets which are 26 feet wide.

W. D. CHAMBERLAIN:— The reason I objected to the T-rail was based on my experience in this city. We have some 8-in. and 6-in. T-rail, and as a rule it does not compare favorably with the 9-in. Trilby or girder rail, which is our standard. The T-rail has a single row of 6 or 8 bolts, as against 12 bolts in our 36-in. joint plate. The joints offset, the rails become cupped, the paving at the joint becomes loose, and breaks up, causing more trouble, as a rule, than the 9-in. rail. On Mission street we laid some 7-in. Trilby rail several years ago, which had a single row of 6-in. bolts at the joints, instead of a double row, which we have in our 106-lb. 9-in. rail. We laid that rail on one or two blocks, and on the adjacent blocks

we laid 9-in. 137-lb. rail, with twelve-hole joints. Two years after being laid we had occasion to do considerable repairing on the joints of the 7-in. rail. No work was necessary on the 9-in. joints although both 7-in. and 9-in. rails were laid at the same time under the same conditions and have been subject to the same traffic since being laid. Personally, I think that is a strong argument in favor of the 9-in. rail. We took up the paving and had to spend several days to get these joints back in shape. The plates had worn on top, and in some cases it was necessary to offset them in order to put them in proper condition. As I mentioned before, we have had 9-in. 106-lb. rail in use for six years, and the joints, generally speaking, are in perfect condition to-day, and we have not had occasion to make any joint repairs on this standard class of work except some slight grinding or filing on a few joints. I notice now, however, that there is a slight tendency to cup at the joints, but this we eliminate by timely grinding. I cannot say the same with regard to any 7-in. rail we have in this city. When we put in the 7-in. rail we expect joint trouble in a few years.

All that I say in this connection is based on what I have seen in this city. I know that the high T-rail has been recommended in the last few years as a very efficient rail. There is no doubt it will be a rail which will be much used in the future. I do not approve of the use of that style of rail in paved streets under the conditions with which we have to contend.

C. H. Clark:— I just want to say one word about your joints. It is very evident, from your description, that your joint plates are thin and buckle under pressure from your bolts. One thing you are probably doing is to use too long a wrench to screw up the bolts. With the buckling of your plates, you lose the strength of the joints.

W. D. Chamberlain:— We have a standing order that the length of our wrenches shall not exceed 24 in. for the ⅞-in. bolt, and 36 in. for the 1-in. bolt. We have absolutely prohibited the use of pipes or any other means to lengthen the wrench. I am satisfied that our standard length of wrenches

only are used and we realize the importance of not straining the bolts.

C. H. CLARK:— The standard thickness of the joints for the 7-in. T-rail is 1⅛ in., and it is impossible for them to buckle, therefore your joints will not go down if the bolts do not stretch.

Mr. Harvey spoke of the type of construction. In regard to the question of drainage in sandy soil, use it any way, it only costs about 7 cents a foot, and you are not taking any chance. In the case of the concrete slab, the moisture under the pavement is supposed to run into the drain provided. I have myself objected to this, although some companies, like the International Railway Co. of Buffalo, use it as a standard.

The brick pavement was placed, as you might say, behind the wooden pavement, on account of its wearing qualities. Wooden pavement will probably outlast the brick pavement 3 to 1, for wearing qualities. For that reason it was placed next the brick pavement. We do not use any brick pavement at all any more on account of its wearing out.

Mr. Harvey was right in regard to the formula for manganese — you cannot specify to a manufacturer what he shall put in, and then make him give you the results.

There was some objection to the design of the plates for the 7-in. rail, as not being strong enough. It must be remembered that a good many companies place the bond under the plate, and therefore room must be left for the bond, and these plates were made thick enough, that if the bolts were drawn up tightly, they would serve their purpose. They are plenty strong enough for the rail, if they are not buckled.

Mr. Entwisle touched on standard layouts. Of course, it is impossible to standardize the frogs, but it is possible to standardize switches and mates. I have worked on the drafting table myself, in one of these manufacturing companies, and if you could see the layout that came in to us you would know that what would apply in Kansas City certainly would not apply in Boston. The switches and mates can be standardized, and should be standardized.

Mr. Kupfer spoke about steel ties. There are two makes practically standard now, and are meeting the wants of people

who have to pay about 80 cents for the wooden ties. Our construction in Cleveland is standard steel tie construction. We pay about 83 cents for white oak ties, and that, compared to $1.62 for steel ties, makes our track work about 50 cents less per foot. Can you see how it is done? Of course, the two ties, white oak ties, would cost the same as one steel tie, but in order to use two white oak ties you have to dig a trench say 21 in. deep. By using two steel ties you can leave an opening between the two steel ties and raise the concrete up so that it is only 5 or 6 in. thick along the pavement, saving the concrete, which will save about 50 cents per foot.

Some gentleman said the 9-in. rail was the only rail to be used for good tracks, on account of the paving blocks not being of sufficient depth. The 7-in. rail ordinarily is stronger than the 9-in. in a comparative sense. That is to say, the overturning moment on the 7-in. rail is less than the overturning moment on a 9-in. rail, and for that reason a 7-in. rail can be made so much lighter for the same amount of strength. The 5½-in. granite paving block is of sufficient depth for all wearing qualities of pavement. One of the largest manufacturers of granite paving blocks, who is located in Wisconsin, is now recommending only a 4-in. paving block, because granite never wears out, and the largest part of the cost is what is paid to the steam railroads for freight.

Some gentleman referred to the drains under the track. That is considered now as the best practice. It was formerly the best practice to put the drain under the center of the track, but you must look ahead to the plumbers and the waterworks men and the gas men, who cut through that track to get to the sewer which is in the center of the street, and they never replace it. I have had a good deal of work spoiled in this way. I have had tracks torn up within a week after they were laid. They cut through the drain and you do not get it replaced. The next best thing is to put it in the center of the street because, as a general thing, they do not always go through the double strip in tapping a sewer.

As to plates in mates of cross-overs, unless a good hard surface is there, the cars going continuously over the cross-overs will wear grooves and just the time you want to use the

mates it cannot be done, as the wheels will ride over the switch, and it is for that reason that plates are put in the mates. They should also be of very hard quality.

PRESIDENT CRECELIUS:— Gentlemen, we have now had a very comprehensive discussion on this part of the report. The recommendations, as approved by the Committee on Standards, will now be taken up for action.

PRESIDENT CRECELIUS:— The first recommendation is that the Types of Track Construction, Type B and Type C as shown on page 471, be approved as Recommended Designs.

W. G. GOVE:— The Committee on Standards has approved Type B as a Recommended Design but has withheld its action on Type C until after this Convention.

I want to say, for the Committee on Standards, in presenting this recommendation, that the Committee on Standards have nothing to do with the Committee on Way Matters. In making recommendations, where there are 13 members as on the Committee on Standards, you could not very well expect them all to be of one mind, very seldom, perhaps never. Where a Recommended Design or Recommended Specification is advocated it implies a doubt and there is doubt. If it is recommended as a Standard Specification or Standard Design, you can take it that practically all the members of the Committee on Standards feel sure of their ground. I am not going to make any comments on this committee's report. Several of the criticisms brought up by both the manufacturers and the representatives of the railroad companies are pertinent, and I think that necessarily action will be taken on some of them. In all of the recommendations of this committee I want to lay stress upon the mere fact that they are put forth as Recommended Designs, implying doubt and, therefore, we want to have some action taken. We want to make a start, and with the understanding that before they are made Standard Design and Standard Specification there will undoubtedly be further work on the part of the ensuing committee, or whenever the subject is brought up in our regular course of work, and action taken based upon the results of

the discussion had here this afternoon. You must bear in mind, however, that this is a Recommended Design only.

C. R. HARTE:— I move that the recommendation of the Committee on Standards be adopted.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the Classification of Soils as shown on page 469 of this report, be approved as Recommended Practice.

W. G. GOVE:— This is disapproved by the Committee on Standards, but it is to be inserted in the *Engineering Manual* under Miscellaneous Methods and Practices.

C. R. HARTE:— I move the adoption of the recommendation of the Committee on Standards.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the Design of Joint for 7-inch 80-lb. and 7-inch 91-lb. Plain Girder Rails be approved as a Recommended Design.

W. G. GOVE:— The Committee on Standards has approved this as a Recommended Design.

C. R. HARTE:— I move that the recommendation be adopted.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that the Design for Drilling Standard Section Rails of 80, 90 and 100-lb., be adopted as a Recommended Design.

W. G. GOVE:— The Committee on Standards has approved this as a Recommended Design.

C. R. HARTE:— I move that the recommendation be adopted.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is that a dimension of one inch be inserted in the diagram in our Recommended Specification for Splice Bars and Joint Plates, as indicating the thickness of the plate on head side of rail at center of bolt holes.

W. G. GOVE:— The Committee on Standards has approved of this recommendation.

C. R. HARTE:— I move that the recommendation be adopted.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next recommendation is with

regard to changes in present Section Wr 1a of our *Engineering Manual,* T-Rails for Use in Paved Streets. The Committee recommends first that this section be made into two parts:

I. Designs of Plain Girder Rails.

II. Plain Girder Rails for Use in Paved Streets.

In Part I will be included all designs of plain girder rails, *i. e.,* new designs of 80, 90 and 100-lb. standard section rails, which are to supersede those shown in Fig. 1 of present Section Wr 1a, *Engineering Manual;* the present Recommended Design for 7-in. 80-lb. plain girder rail (Fig. 3, Sec. Wr 1a, *Engineering Manual*), and a new section for a 7-in. 91-lb. rail to supersede our present design for a 7-in. 100-lb. rail shown in Fig. 2, Sec. Wr 1a, *Engineering Manual.*

In Part II will be included new subject matter revising subject matter in present Section, together with designs for Plain Girder Rails.

W. G. Gove:— The Committee on Standards has approved of these changes and new recommendations.

C. R. Harte:— I move that the recommendation be adopted.

(Motion duly seconded, stated and carried.)

President Crecelius:— Unfortunately there is one recommendation of the Committee on Way Matters that was omitted from the recommendations as approved by the Committee on Standards. This is with regard to the Specifications for Special Work.

The Committee on Way Matters recommends that this be adopted as a Recommended Specification.

W. G. Gove:— The action of the Committee on Standards is that the adoption of this as a Recommended Specification be approved.

C. R. Harte:— I move that the action in this respect be approved.

(Motion duly seconded, stated and carried.)

C. H. Clark:— Will that change of ½-in. from 1-in. be made in paragraph 1(*b*)?

President Crecelius:— I will ask Mr. Gove to explain the attitude of the Committee on Standards in regard to such matters as that.

W. G. Gove:—As I understand it, all matters relating to the Committee on Standards and the recommendations to the Engineering Association are revised. The results of the Convention are carefully considered and any conflict in the various clauses, unless they are really technical errors, are harmonized, and the subject matter straightened out in that way.

R. B. Fisher:—As to this matter of the Test Coupons: You are asking manufacturers to cast small test coupons on large castings, which is not practical; not required by the steam roads in their specifications or by any of the manganese societies. You will get poor castings if you insist upon this. You will get castings which will not stand up in service, because if we make our heat treatments suitable for the small test coupons, then the big castings will not receive the proper treatment. If you are going to insist upon this now, and it goes through as recommended practice, some of the smaller companies, not the larger ones, but the smaller companies, not having their own engineers will require it because it is A. E. R. E. A. recommended practice, and they will ask for special work built accordingly.

I believe that this should be carefully reconsidered and perhaps the section can be adopted with the exception of this one feature and that can be brought up at a future Convention.

President Crecelius:— In answer to the question raised by the gentleman I will say that the situation with regard to this specification is this — that it is merely a Recommendation that the Convention approve of the preservation of this subject matter for retention as live data and that the Association shall include it in its *Engineering Manual.* Unless action of this kind is taken, the benefit of this work will be lost. If the point you have raised is correct, that it is impossible to secure results by reason of such heat-treated pieces, that fact, of course, will become known and straightened out, just as our trolley wire specifications have been straightened out in regard to torsion and twist and have eventually been harmonized.

C. R. Harte:— Will Mr. Entwistle advise me whether this question of treatment of the test piece came before the Committee? Did the manufacturers earlier in the game recognize

this apparent discrepancy and bring it before the Committee, so that the Committee itself had the benefit of that information, or is it something which has recently come to the manufacturers' attention?

E. B. ENTWISTLE:— The manufacturers were notified of the second day's meeting of the Committee, and, as I understand from Mr. Kimball, they had passed on that matter at the first day's meeting, so that when the manufacturers got into the meeting, that matter had been passed over and we were not invited to discuss it. The matter was taken up later by letter with Mr. Kimball, and he agreed with the manufacturers who are represented in the letter which was read that it should be changed, but that it was too late to do so, as it had already been approved and the report had been submitted.

ACTING SECRETARY STOCKS:— After the conference of the manufacturers, when you first considered this specification, was this section with regard to the test piece on the side of the main casting in the mold in the specification, as originally drafted by your Manufacturer's Committee?

E. B. ENTWISTLE:— I think not.

ACTING SECRETARY STOCKS:— How did it get in?

E. B. ENTWISTLE:— I think it was done at the first-day meeting of the Committee on Way Matters before the manufacturers were invited in to discuss this matter. We did not discover it until after the Committee on Way Matters had adjourned.

C. R. HARTE:— I move that the admirable report on Way Matters be received, as a whole, and that a vote of thanks be extended to the committee.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— We have reached the point in our program where we will take up as the next subject, a paper entitled "Some Factors Affecting the Application of Wood Preservation to Electric Railways," by Carlile P. Winslow and Clyde H. Teesdale, of the Forest Products Laboratory, Madison, Wis. In the absence of the authors the paper will be presented by Mr. C. A. Kupfer.

SOME FACTORS AFFECTING THE APPLICATION OF WOOD PRESERVATION TO ELECTRIC RAILWAYS

By Carlile P. Winslow and Clyde H. Teesdale, *Engineers in Forest Products,*

Forest Products Laboratory, Madison, Wis.

PRESENT SITUATION

Wood preservation, or the impregnation of wood with various substances to retard its destruction by decay, has been practiced for a great number of years. In this country, however, its development on an extensive scale has taken place only within the past 15 years. With but two commercial plants in operation in 1860 and but 15 in 1900, we find 75 in operation in 1910 and 95 in 1914. The development is even more strikingly shown by a glance at Table 1, which shows that the amount of wood annually treated was practically doubled between 1908 and 1914, amounting in the latter year to approximately 160,000,000 cu. ft.

Table 1.—The Amount of Wood Treated in the United States, 1908 to 1914.

Preservative	Year	Total material treated each year
		Cubic feet
All preservatives	1908	82 381 908
	1909	75 946 419
	1910	100 074 144
	1911	111 524 563
	1912	125 931 056
	1913	153 613 888
	1914	159 582 639

It is the steam railroads that have supplied the impetus to this striking development. Of recent years from 80 to 85 per cent of the total amount of wood treated has been ties for steam roads, and while only approximately 30 per cent of the total number purchased in 1914 were so treated, this is a gratifying proportionate increase when compared to only 24 per cent treated in 1911.

With the increasing use of treated material by the steam roads, it is well to consider to what extent the electric railways are progressing in that direction. Unfortunately, statistics for the past three years are not available, but in 1911 only 15 per cent of the ties purchased by electric railway companies were treated as compared to 24 per cent for the steam roads. While figures are not available to

show the per cent of poles treated by the electric railway companies alone, the total pole purchases are reported for 1911 as approximately three and one-half million, with only 656,000, or 19 per cent, reported as being treated. Twenty-three per cent of the total purchases were for electric railway, light, heat and power companies.

Reasons for this somewhat restricted use of treated material by the electric companies are not difficult to ascribe. The extensive development of electric interurban lines, with the consequent increasing demand for ties and poles, has taken place largely within the past decade. In many cases, the ties originally placed are still doing service while even a greater proportion of the poles have not yet required replacement. Hence, renewal charges have not increased to the extent that may be anticipated in the future, and until the burden of such expenses has been felt, it is but natural for the question of wood preservation to receive little consideration. There is no question, however, but that it will yearly become of increasing importance. Ties and poles purchased by the different electric companies in 1911, with the resulting expenses for placement, involved an expenditure of approximately $15,000,000, and when other forms of material, such as posts, cross-arms, bridge timbers, etc., are considered, together with the development of the industry, an estimate of $20,000,000 for the present annual expense does not appear unreasonable. As the material already in place deteriorates to the point necessitating removal, the figures will be increased to an amount not possible to closely estimate but undoubtedly appreciable in its magnitude.

GENERAL FACTORS TO BE CONSIDERED

The factors involved in the technical aspects of wood preservation are many and varied, and the scope of this paper does not permit of their full discussion. The references appended list publications which cover the subject exhaustively. Suffice it to here say that contrary to a somewhat popular impression, decay of wood is due to the action of bacteria and fungi or low forms of plant life which require for their development certain amounts of oxygen (air), moisture, and food. The complete elimination of any one of these factors will prevent decay, and this is customarily attempted by injection into the wood of various compounds which either act as poisons to the fungi, or retard the absorption of moisture, or to a greater or less extent combine these properties. Of the preservatives mostly used, coal-tar creosote and similar products, and zinc chloride stand in the foreground, being used both separately and in combinations. The customary methods of injecting the preservatives are the pressure or cylinder process, in which the material, on trucks, is run into horizontal steel cylinders, and the preservative injected under pressure of from 100 to 200 lb. per sq. in.; the open-tank process, where the material is merely immersed in the preservative in open tanks and subjected to varying

temperatures and times of treatment; and the brush method, in which the preservative is applied with a brush in a similar manner to paint. Of the three processes, the first is the most widely used, practically all ties and material which is treated in large quantities and which can be assembled at a treating plant, being so handled. The second process is especially adapted for poles and posts, where it is only desirable to treat the "butt", thus protecting the material from decay at the ground line where it first occurs; and the third process is adapted for use where it is impracticable to secure material treated by either of the other methods.

Whatever may be the preservative and process under consideration, or however much a preservative treatment may in itself appear desirable, the final governing factor is the cost. If economy does not result from its use, it is evidently a poor business proposition. In considering the cost, however, four variable factors must be determined. These are:

1. The cost of the untreated material in place.
2. The cost of the treated material in place.
3. The life or length of service from the untreated material.
4. The life or length of service from the treated material.

With these factors determined, an exact and accurate comparison of the relative costs may be made by using the standard amortization formula and comparing the resulting annual charges.

An explanation of exactly what is meant by "annual charge" can best be given by an illustration as follows: Assume an untreated tie to cost 80 cents, the cost of placing in the track to be 20 cents additional, and that the tie will have a life of 10 years. On this basis an expenditure of $1 is made which must be replaced every 10 years. This expenditure is equivalent to an investment of $1 which, if figured to draw interest at 5 per cent, compounded annually, at the end of 10 years would amount to $1.63. From a theoretical standpoint $1.63 represents the actual amount which must be met at the end of the 10-year period. In order to provide a sum equal to this figure at the given time it will be necessary to put aside a certain amount of money each year so that at the end of 10 years the total sum put aside, together with interest at 5 per cent, compounded annually, will be the sum required. This amount of money which is set aside annually is known as the "annual charge" and gives a correct figure for the actual annual cost, or cost per year, of the tie under consideration.

Fig. 1 has been prepared as a convenient means for determining annual charges resulting from various initial expenditures with various years of service. In using this figure the following points should be observed: The initial investment **(P)** is represented by curve No. 10 and the annual charge is given in per cent of this initial investment **(P)**. For ties it is convenient to assume **(P)** in all cases as $1. If a tie costs $1 in place in the track and has a life of 10 years, it is

only necessary to find the intersection of curve No. 10 with the vertical line corresponding to 10 years' life, follow the horizontal line passing through this intersection across to the left of the figure, and the resulting annual charge is found to be 13 per cent of **(P)** or 13 cents in this case where **(P)** is taken as $1. In case the cost of the tie in place in the track was some other amount, say 80 cents or

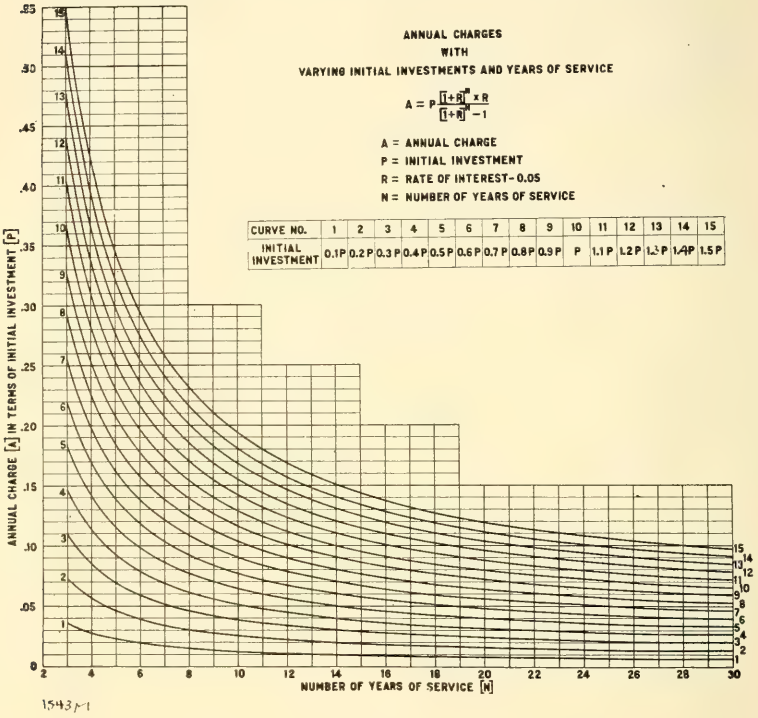
ANNUAL CHARGES
WITH
VARYING INITIAL INVESTMENTS AND YEARS OF SERVICE
$A = P\frac{[1+R]^N \times R}{[1+R]^N - 1}$
A = ANNUAL CHARGE
P = INITIAL INVESTMENT
R = RATE OF INTEREST - 0.05
N = NUMBER OF YEARS OF SERVICE
CURVE NO. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
INITIAL INVESTMENT 0.1P 0.2P 0.3P 0.4P 0.5P 0.6P 0.7P 0.8P 0.9P P 1.1P 1.2P 1.3P 1.4P 1.5P
ANNUAL CHARGE [A] IN TERMS OF INITIAL INVESTMENT [P]
NUMBER OF YEARS OF SERVICE [N]
1543 M1

FIG. 1.

$1.20 instead of $1, the resulting annual charge could be readily determined in the same manner as before by following down the curves No. 8 or No. 12, respectively, and keeping in mind that the annual charge would be in per cent of $1 as heretofore.

Should poles be under consideration, it would be more convenient to assume **(P)** as $10, in which case the annual charges as read would in all cases have to be multiplied by 10.

In addition to determining directly the annual charge resulting from any initial expenditure over a given period of years, the diagram can also be used in other ways. For example, if the annual charge with an untreated tie of a given species is assumed or determined and it

is estimated that the use of a treated tie would increase the initial cost by 30 cents, it can be at once determined from the diagram what life would have to be secured with the treated tie to give an annual charge equivalent to that for the untreated.

APPLICATION TO TIES

An attempt to apply the foregoing principles in determining the advisability of a preservative treatment for ties used in electric railways, leads at once to difficulties. Take, for example, ties for use in interurban lines. In any given case it is simple to determine the approximate cost of both the treated and untreated material in final place; and a working knowledge of the approximate life of the untreated species of wood which it has been the practice to use can also be determined within a reasonable degree of accuracy. These data can largely be determined for a given company from correspondence with the operators of treating plants and tie dealers, and from their past records. To secure reliable data, however, on the life of untreated species which may be available but not used in the past and on the life of material treated with different preservatives and processes, is a different matter. It is not available in published form, and without it a true determination of the economics of any given case is impossible. It is, of course, possible to generalize and draw broad conclusions from the experience of the steam roads, since the conditions to which the ties are subjected are to some degree comparable. For example, it can be generally assumed that the life of untreated ties will vary from 2 to 3 years for sap pine in the South to from 7 to 9 years for white oak and 10 to 12 years for cedar in Michigan, and properly creosoted ties will give at least from 15 to 20 years' life, with prospects of even a longer service under certain conditions. On this basis it can be shown that a white oak tie costing 85 cents in place in the track with a life of 8 years will give an annual charge of approximately 13 cents, as compared to a creosoted red oak tie costing $1.20 in place in the track with a life of 20 years, giving an annual charge of approximately 10 cents, and there remains no question of the advisability of the treatment. Suppose, however, that the available species were beech, maple, hemlock and tamarack, whose natural durability is not widely different. To what might the manager turn for reliable data upon which to base his decision? Would it be fair to assume a longer life than secured by the steam roads due to less abrasion and mechanical wear of the ties resulting from the lighter wheel loads, or is this more than offset by the use of a tie of lower quality than usually taken by the steam roads? Such questions as these can only be finally answered with data resulting from actual service tests.

With ties for use in tracks laid in unpaved and macadam streets, the situation is more difficult than with ties for interurban lines.

Under the former condition, the ties are completely covered and there is a question as to whether this covering accelerates or retards decay. It may be argued that the covering is sufficient to reduce the supply of air or oxygen below the amount requisite for the development of the fungi, and thus the conclusion be reached that the ties will last longer than in open track; on the other hand, it may be equally argued that the covering will result in the ties being constantly damper and thus hasten their decay. It is impossible at present to state with accuracy what may be the ultimate result. In an attempt to secure information bearing on the subject, an examination of the properties of several companies operating in the middle West was

FIG. 2. SEVEN-FOOT CEDAR TIES REPORTED AS BEING REMOVED AFTER BEING IN MACADAM STREET IN ILLINOIS NEARLY SIX YEARS, WHEN CONSTRUCTION WAS CHANGED TO HIGH RAIL AND BRICK PAVEMENT. TIES WERE NOT CONSIDERED GOOD ENOUGH TO GO BACK BUT GOOD ENOUGH FOR REPAIRS IN OPEN TRACK.

undertaken, and the opinions of the officers secured. One company in Indiana reported oak and beech ties laid on gravel ballast as badly decayed when removed after 2 years' service; Fig. 2 shows the general appearance of some cedar ties reported as having been removed after six years' service in a macadam street in Illinois; while officials of two companies in Illinois estimated the life of untreated cedar and white oak as 11 to 12 years and 8 to 10 years, respectively, or the same as for open track. It would appear, therefore, that it is at least questionable if any greater life is secured from ties in this type of construction than in open track, while possibly the life is

less. In the absence of further data, an assumption of life equal to or slightly less than that in open track would appear reasonable, on which basis it will be possible in at least many cases to determine the relative annual charges with treated and untreated ties with a fair degree of accuracy. It must be remembered, however, that the placement or replacement costs are higher than for ties in open track — from at least 40 to 50 cents — and this will affect the resulting annual charges.

A third and important condition under which ties are used is in tracks in paved streets. The situation is complicated not only by lack of authentic data, but by the variety of types of construction in use. Some of those in use in the Middle West are:

1. A monolithic construction of 6-in. concrete under and between the ties and about 1-in. over the top of the tie, followed by a 1 to 2-in. sand cushion upon which the brick is placed.
2. Six inches of concrete foundation, then about a 1-in. sand cushion upon which the tie is placed, then concrete between and over tie to about 1 in., followed by sand cushion and brick.
3. Six to 8 in. of rock or gravel ballast on which the tie is placed, then concrete between and slightly over the tie, followed by sand cushion and brick.

Some light is thrown on the service secured from untreated ties in these types of track by the following summation of opinions expressed by officials of a number of companies operating in the Middle West:

SUBSTANCE OF OPINIONS AS EXPRESSED BY OFFICERS OF VARIOUS COMPANIES

LOCALITY	Species	Life untreated	Remarks
		Years	
Michigan	White oak	12–15	Life of tie equal to life of rail.
Michigan	White oak	20	Life of tie equal to life of rail.
Michigan	White oak	10	
Illinois	White oak	20–25	Equal to life of rail provided tie is not disturbed.
Indiana	White oak	20	Life of tie equal to life of rail.
Illinois	Hemlock Tamarack Cedar	15–20	Life of rail.

There was also rather a general consensus of opinion among the operators of the Michigan properties that the tie would last as long as the rail provided it was not removed from the track, but that, at least with cedar ties, decay had been observed to advance quite rapidly after removal from the track.

In substantiation of the opinions expressed in Illinois, it was stated that untreated tamarack ties, which had been in place in a paved street for approximately 17 years, were examined when it became necessary to reconstruct the track and pavement. These ties were found in excellent condition and were replaced in the street when the new pavement was laid. This is the most striking case of long service in a paved street which has come to the attention of the writers.

Somewhat contradictory to the foregoing is the following data which were secured:

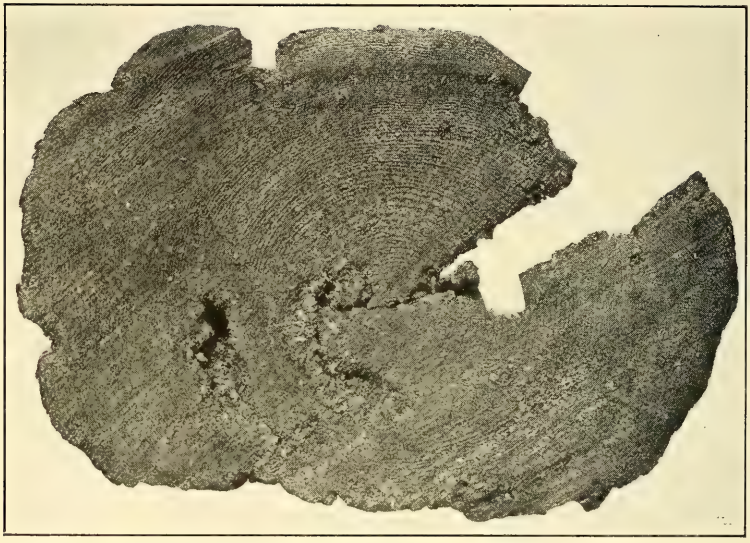

FIG. 3. SECTION OF CEDAR TIE REMOVED FROM PAVED STREETS IN MICHIGAN.

This tie said to have been removed in October, 1913, after eight or ten years' service and placed in storage yard. It was sent to the laboratory for examination in November, 1913.

MICHIGAN:

Untreated ties in a paved street where repaving was under way were examined. These ties were reported as having been in service for from 8 to 10 years. A number of cedar ties showed decay, especially on the ends, although the oak appeared in fair condition. Some of these ties had been removed from the street and placed in the store yard with a view to further use in open track. These ties were in bad condition and most of them not fit for further use. Fig. 3 and 4 illustrate the condition of two cedar ties, one of which had been removed from this street for approximately one month and the other one for approximately three months. It was reported that both of these ties looked perfectly sound when removed.

MICHIGAN:

Untreated red oak ties said to have been in a brick paved street laid on gravel for 8 years were examined as the entire reconstruction of the street was under way. They were practically all in the most advanced stages of decay. The middle portions of the ties were in most cases entirely destroyed, leaving only small disconnected sections under the rails.

FIG. 4. SECTION OF CEDAR TIE REMOVED FROM PAVED STREETS IN MICHIGAN.

This tie said to have been removed in June, 1913, after eight or ten years' service, and placed in storage yard. It was sent to the laboratory for examination in November, 1913.

ILLINOIS:

Ties were examined in the store yard which were said to have been removed after 9 years' service in a paved street consisting of 6-in. rock ballast on which the tie was laid with concrete then placed between and over the ties and brick on top. Much decay on the bottoms and ends of the ties was noticed. Fig. 5 shows condition of four of these ties, said to be white oak.

Other untreated ties seen in the store yard, which were said to have been removed after 20 years' service from a brick paved street laid without concrete, showed bad decay.

It hardly seems reasonable to assume from all of the foregoing that it is safe to expect a life of 20 or more years from an untreated tie in a paved street. Possibly that might be the case in solid concrete construction where practically all of the tie is surrounded with concrete, but even with this type of construction it is a question whether it would not be more proper to figure that the average life would vary somewhere between 10 and 20 years.

Next consider the relative costs of replacement in the track. A variety of figures have been given on this point. One company placed the average cost at from 25 to 40 cents, and the maximum as high as $4. From another a cost of $1.50 was given, while from a third the cost of replacing in a brick pavement was given as $4, and in one case (stated to be exceptional) in replacing in asphalt as high as $12. It is rather difficult from this range of figures to arrive at any fair average. Of course, if after 10 to 12 years for some reason the rail gives out at the joints or the pavement becomes destroyed,

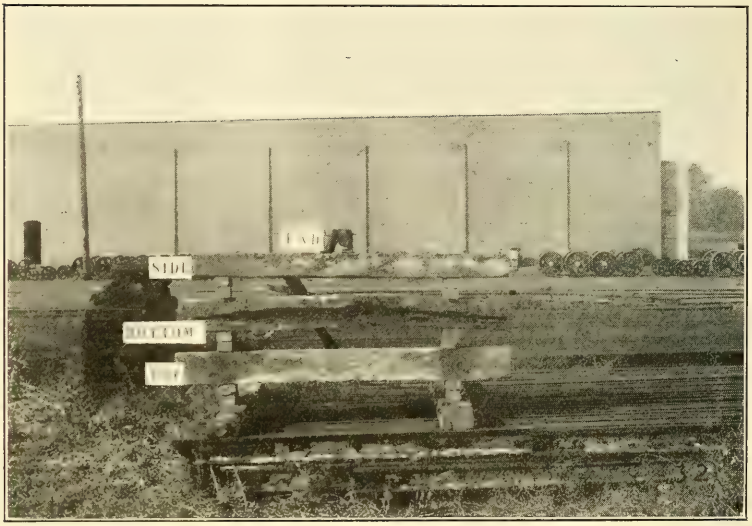

FIG. 5. FOUR TIES IN STORE YARD IN ILLINOIS.

These reported as white oak, after nine years' service in paved street, where they were aid on rock ballast with concrete to within about 2 inches of top of tie, followed by sand cushion on brick pavement.

or for some other reason it is necessary to reconstruct the street and track, the replacement figures per tie would probably only be from 25 to 40 cents as it would be incidental to the other work. Assuming that the tie to which the rail is fastened becomes partially decayed at that point or around the spike holes, this would probably permit some vibration and movement of the rail, which in turn would eventually damage the street. There would be no way to tell whether or not the tie was decayed until the pavement was removed so that serious difficulties and large expense might eventually result from only a partial decay of the tie at this vital point. Under such conditions it is evident that the cost resulting from the decaying tie would be very great. Furthermore, assuming that it should become

known, or at least strongly felt, that a tie in a paved street was decaying while the rest of the equipment remained satisfactory, it is at once evident that the cost just to replace the tie would be excessive and doubtless the high figure of $12 per tie might be reached.

With the foregoing in mind consider the cost of the tie in place and the resulting annual charge. Allowing 65 cents for a 6 by 8-in. by 8 ft. white oak tie, and $1.50 for replacement in the track, the cost amounts to $2.15. With a life of 20 years this is equivalent to an annual charge of slightly over 17 cents per tie. If, now, an allowance is made of 26 cents for a 6-lb. treatment with coal-tar creosote, together with the same cost of 65 cents for the untreated tie and $1.50 for replacement, a life of 25 years will give an annual charge of slightly less than 17 cents per tie, and of 30 years of about 15.5 cents. It is entirely reasonable to assume that if a life of 20 years is secured from the untreated tie, at least from 5 to 10 years longer will be secured from the treated one. Possibly even a life of 20 years longer, or equal to twice the life of the rail, might be attained.

Viewing the matter from another standpoint and assuming the life of the untreated tie as 10 years, the annual charge amounts to approximately 28 cents per tie, while the treated life as outlined above would amount to only about 19 cents per tie on a 20-year life. If, then, a 10-year life is a more reasonable one for the untreated tie in the paved streets, a saving by the use of the treated tie of approximately 9 cents per year per tie would result provided a life of 20 years was secured.

With the foregoing figures in mind it appears to be desirable to use treated ties in paved streets. The placement costs are so high that even in the absence of authentic service records, the wider use of treated material for this purpose would seem to be justified. However, until more service data is available, which species and kinds of treatment will yield the greater economy can be predicted with no greater certainty than for ties for the other kind of service.

In the selection of a preservative, difficulties are again encountered due to lack of authentic records. That coal-tar-creosote and similar products will give satisfaction there seems no reason to doubt. With zinc chloride, however (a preservative widely used by the steam roads and having the advantage of comparatively low cost), some question has arisen as to its corrosive effect on the spikes due to an electrolytic action induced by the return of the electric current through the rails. The following quotation from a letter of November, 1913, from a large traction company in Indiana bears on this point:

> We first used treated ties in 1909. These were treated only with zinc chloride. Commencing the next year we put in the zinc creosote as well as some straight creosote treated ties. The zinc creosote and straight creosote ties have not been in service long enough to permit of any estimate of their life, but up to this time none of them has shown any signs of decay.

The straight zinc chloride treatment does not appear to be a good tie for us, as we have found that there is some chemical action which eats away the spikes, and to some extent the rail where the spikes come in contact with it. This we believe to be due to the presence of metallic zinc which forms an electrolytic action and corrodes the spikes. About a year ago we took some of the spikes out of these ties and found that probably 30 per cent of the spike had been eaten away. In riding over our track it is easy to pick out the ties treated only with zinc chloride on account of the rusty appearance of the tie adjacent to the rail.

In addition, it has been reported by officials of a company operating in a large city that pine ties treated with zinc chloride and laid in tracks in paved streets caused excessive corrosion and almost total destruction of some of the spikes in less than two years. One other company reported similar difficulties and has abandoned the use of zinc treated ties for this reason.

To what extent these results may be taken as widely applicable is a matter which can only be settled by further study, but they well illustrate the need for a summation and correlation of the results secured by different operators throughout the country.

APPLICATION TO POLES

In the application of a preservative treatment to poles lies the largest proportionate saving. Aside from the direct cost of the pole, the expenses incident to delivery, framing, gaining, assembling of cross-arms, digging of hole, and final placement, reach an appreciable amount, which may be conservatively taken at from $3 for a 30-ft. pole to $8 for a 60-ft. pole. On this basis an allowance of $14 for a 40-ft. cedar pole in place in the line is fairly representive of conditions, at least, as found in the Middle West. With a life of from 15 to 18 years, this would result in an annual charge of from $1.35 to $1.20.

The cost of treating such a pole with creosote* may be taken as about 21 cents for a two-coat brush treatment of the butt, and about $1.15 for an open-tank butt treatment. It is at once evident that only a slight increase in life will pay for the additional cost of either of these treatments. Chestnut poles treated by the open-tank method and placed in an experimental line in Pennsylvania by the Forest Service have after 8 years showed practically no decay at the ground line, while the brush treated poles showed after 8 years about one-fourth the decay at the ground line that the untreated poles showed after 5 years. It is entirely reasonable, therefore, to assume that the brush treatment will add at least 3 years to the life of the pole if no more and that the open-tank treatment will add 10 years, possibly more. On this basis, using the same figures as originally used for the untreated poles and adding the costs of treatment as estimated above,

* Cost of creosote taken at 8.5 cents per gallon.

together with the increased life of 3 years for brush treatment and 10 years for open-tank treatment, the annual charges would be from $1.10 to $1.20 for the brush treatment and from $1 to $1.05 for the open-tank treatment. With the open-tank poles this would mean a saving per year of from 20 to 30 cents per pole.

While the use of treated poles can be generally recommended as good practice, it is evident that in many localities and under many conditions it will not be practicable. This is especially true in the western states, where the question will frequently be not as to the desirability of treatment, but the selection of a species for use untreated. It is this phase of it — the relative life of different untreated species, available for use but not widely used in the past — upon which additional data is needed. Until secured, the managers of the various companies will continue to have difficulties of this character.

FIG. 6. UNTREATED SOUTHERN YELLOW PINE BRIDGE TIMBERS.

These reported as removed after twelve years' service in a bridge of an Illinois Interurban Railway.

APPLICATION TO OTHER FORMS OF TIMBER

While ties and poles are unquestionably the material offering the largest possibilities for the application of a preservative treatment, other forms such as bridge timbers, cross-arms, posts, crossing-planks, insulator pins, etc., should not be overlooked. Fig. 6 shows the condition of some untreated southern yellow pine bridge timbers reported as removed on account of decay after 12 years' service. When the replacement charges incident to such work are considered, the value of properly treated material for this purpose cannot be questioned. With cross-arms, especially where the life untreated is less than the life of the pole, there is also little question as to the resulting economy of a preservative treatment. In all of these cases however unanswerable questions will arise,— What life may we expect

from untreated bridge timbers and cross-arms of different species in different sections of the country? What character of treatment is advisable to insure the desired life? How much should we figure in increasing the untreated life? With posts, what life may be expected from the portions not in contact with the ground? Is a butt treatment or an entire treatment of the post the more desirable? With insulator pins, to what extent is decay prevalent and to what extent is their destruction due to other causes? Fig. 7 illustrates the condition of four pins reported as having been used in a high voltage line in Michigan and supposedly treated with a preservative. On examination, pins A and D both showed extensive decay, while none was present in the other two.

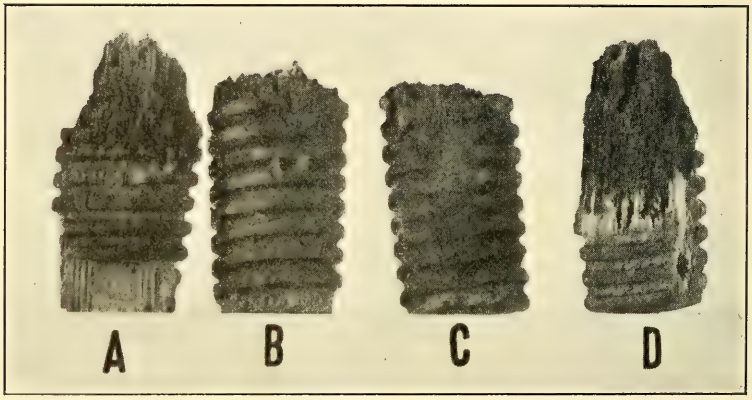

FIG. 7. INSULATOR PINS REPORTED TO HAVE BEEN USED IN A HIGH VOLTAGE TRANSMISSION LINE IN MICHIGAN.

A, *B*, and *D* on examination found to be red oak. *C* found to be white oak.

CONCLUSIONS

The substance of the foregoing discussion may be briefly summarized as follows:

1. The application of wood preservation in the United States is rapidly expanding, but is apparently not being adopted by the electric railway companies, to the same extent as by the steam railroads.

2. A considerable opportunity exists for the wider use of treated ties in interurban lines but to what extent this generally applies can only be determined by a careful consideration of the facts in each case.

3. With ties for tracks in unpaved and macadam streets, the opportunities for a wider use of treated material are, in general, proportionately greater than with ties for open track. This is due to the somewhat higher charges for placement and renewals.

4. Ties for tracks in paved streets appear to offer the widest proportionate field for the application of a preservative treatment to ties. Failure of ties from decay in such construction results in such heavy expenses that, if only from the standpoint of precaution, the use of treated ties seems desirable.

5. With the exception of poles to be used in inaccessible localities, the use of treated poles can be generally recommended. Even a 2-coat brush treatment will under general conditions amply repay the resulting expense. The problem is not so much a question of the advisability of treatment as it is a question of selection of species and their durability where not in contact with the ground.

6. With other forms of material, such as posts, cross-arms, etc., a preservative treatment is in many cases desirable, but here again questions as to the service secured from different species under different conditions is needed.

7. The lack of published authentic data covering the life of various species, both untreated and treated, in the various conditions to which it is subjected by the electric companies permits of no accurate determination of the economic aspects in the use of treated material.

It is the last of the above which is the most significant. A systematic collection, compilation and analysis of the results experienced by the various companies throughout the country would be most helpful. The steam roads through their committees of the American Railway Engineering Association have for many years collected such records affecting their interests; similar action on the part of your association should yield results of equal value.

APPENDIX A

PARTIAL BIBLIOGRAPHY OF THE AMERICAN WOOD PRESERVING INDUSTRY

BOOKS

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Timber Preservation, Samuel Rowe. Pettibone-Sawtell & Co., Chicago, 1904.

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PROCEEDINGS

Proceedings of the American Wood Preservers' Association, 1904–1915.

Proceedings of the American Railway Engineering Association: Reports of Committee on Wood Preservation, from 1909 to 1914.

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Report of Sub-committee on Standard Specifications for Wood Block Paving. American Society for Municipal Improvements — 1914.

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Chemical Treatment of Timber, Hermann von Schrenk, *Railway and Engineering Review*, (*June 6, 1903.*) 43:23.

Cincinnati Bureau of Municipal Research: Bulletins — Wood Paving and Preservation.

Preservative Treatment of Timber, O. Chanute, *Journal Western Society of Engineers*, Chicago. (*April, 1900.*)

Report on Creosoted Wood-Block Pavements, John Ericson, City Engineer of Chicago.

Seasoning and Preservative Treatment of Wooden Cross-ties, F. J. Angier. Paper read before New York Railroad Club, February 18, 1910. *Engineering Record* (*February 26, 1910*).

Steaming Timber Before Treating with Preservatives, O. Chanute. *Railroad and Engineering Review* (*March 2, 1907*), 47:9.

Preservative Treatment of Wood, Irving W. Bailey. *Forestry Quarterly.* (*March, 1913.*)

Condition of Experimental Poles, C. H. Teesdale. *Engineering News.* (*November 27, 1913.*)

Efficiency of Various Parts of Coal-Tar Creosote Against Marine Wood Borers, C. H. Teesdale. *Engineering Record.* (*September 12, 1914.*)

Dry Rot in Factory Timbers, F. J. Hoxie. Associated Factory Mutual Fire Insurance Cos., 31 Milk Street, Boston, Massachusetts, 1914.

PRESIDENT CRECELIUS:— You have all enjoyed the very thoroughly interesting paper which has been so ably presented by Mr. Kupfer.

C. R. HARTE:— I move that the thanks of the Association be extended to Messrs. Winslow and Teesdale for their paper, and to Mr. Kupfer for its presentation.

(Motion duly seconded, stated and carried.)

C. R. PHENICIE:— Then I ask if it would be proper to make a motion that this Association act on the suggestion in this paper by the appointment of a committee who may gather statistics from the member companies as to their experiences with the various forms of wood treatment.

PRESIDENT CRECELIUS:— It would be much better to have that matter go through the Executive Committee of the Association in regular form, and have it referred to the Committee on Subjects. Your remarks on the discussion of this subject bring the matter before the Committee on Subjects. A motion is not necessary.

We will now proceed to the next business, the Report of the Committee on Heavy Electric Traction. Mr. E. R. Hill, who is Chairman of this Committee, is unable to be present and in his absence the report will be presented by the Acting Secretary.

REPORT OF THE COMMITTEE ON HEAVY ELECTRIC TRACTION

To the American Electric Railway Engineering Association:

GENTLEMEN.— The Committee has taken up this year the following subjects assigned by the Executive Committee:

(*a*) Clearance lines for third-rail working conductors, as follows: This to be a further joint study with the various other Railway Associations of the equipment clearance line shown on the third-rail equipment diagram adopted by this Association at the 1912 Convention, between the points **FE** and the gauge line of the nearest running rail and the location of the third-rail clearance line between point **ET** and the gauge line of the nearest running rail.

(*b*) Further consideration of definition of third-rail gauge, with reference to question: Should there be a definition of the term "Gauge Line of Third-Rail" to go with the above?

(*c*) Protection of contact rail where a protected third-rail is used.

(*d*) Study of modern electric locomotives.

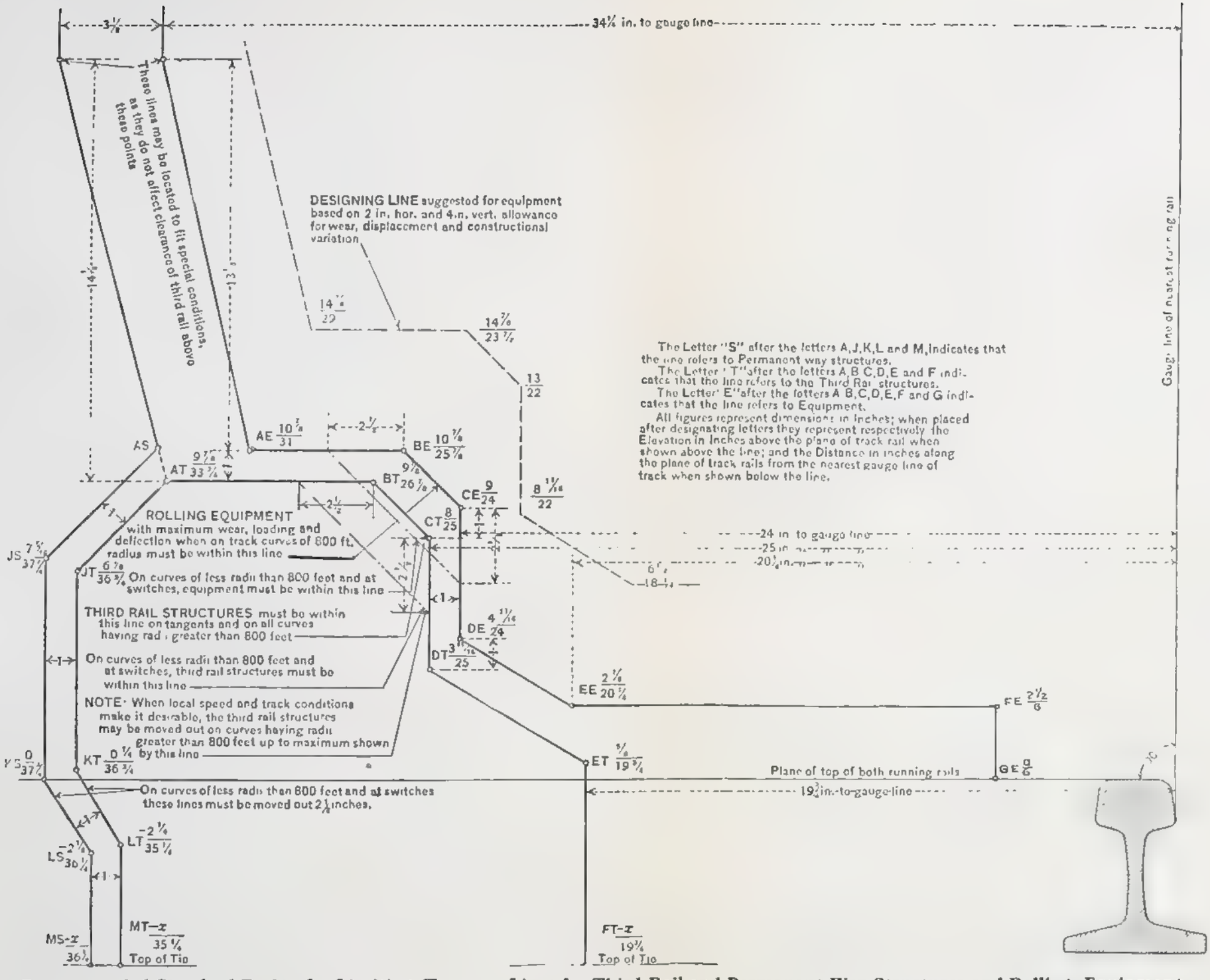
This work was taken up by two sub-committees, Messrs. Katté, Hazelton and Bosenbury being the Sub-committee on Third Rail Matters and Messrs. Murray, Quinn and Hill, the Sub-committee on Electric Locomotives.

CLEARANCE LINE FOR THIRD-RAIL WORKING CONDUCTORS

This matter has now been taken up jointly with the American Railway Association and the American Railway Engineering Association and agreement reached in accordance with the following recommendation, in fact, these other Associations have already adopted the following change in the standard diagram. The Committee, therefore, recommends that the American Electric Railway Engineering Association's Standard Diagram for Clearance Lines for Third-rail Working Conductors have the rolling equipment line changed so that points $\mathbf{FE}\frac{2\frac{1}{2}}{15}$ and $\mathbf{GE}\frac{0}{15}$ become $\mathbf{FE}\frac{2\frac{1}{2}}{6}$ and $\mathbf{GE}\frac{0}{6}$. This change is indicated on the attached diagram, which, according to this recommendation would now become a Standard.

In regard to the designing line for equipment, which on the present diagram ends at a point 18¼ in. from the gauge line of the nearest track rail and 6½ in. above the plane of the top of running rails, it has been suggested that this be extended toward the running rail at some point say 6 in. from the gauge line. The consideration of this change has not yet been acted upon by the Committees of the American Railway Association and the American Railway Engineering Associa-

Rec


3 1/8
34 1/4 in. to gauge line
These lines may be located to fit special conditions, as they do not affect clearance of third rail above these points
DESIGNING LINE suggested for equipment based on 2 in. hor. and 4 in. vert. allowance for wear, displacement and constructional variation
14 1/8 / 29
14 7/8 / 23 1/2
13 / 22
8 1/16 / 22
The Letter "S" after the letters A,J,K,L and M, indicates that the line refers to Permanent way structures.
The Letter "T" after the letters A,B,C,D,E and F indicates that the line refers to the Third Rail structures.
The Letter "E" after the letters A,B,C,D,E,F and G indicates that the line refers to Equipment.
All figures represent dimensions in inches; when placed after designating letters they represent respectively the Elevation in inches above the plane of track rail when shown above the line; and the Distance in inches along the plane of track rails from the nearest gauge line of track when shown below the line.
Gauge line of nearest running rail
AS
AT 9 7/8 / 33 1/4
AE 10 3/8 / 31
BE 10 1/8 / 25 1/8
BT 9 1/8 / 26 1/8
CE 9 / 24
CT 8 / 25
DE 4 11/16 / 24
DT 3 / 25
EE 2 1/8 / 20 1/4
FE 2 1/2 / 6
GE 0 / 6
ET 1/8 / 19 3/4
JS 7 7/8 / 37 1/4
JT 6 7/8 / 36 3/4
KS 0 / 37 1/4
KT 0 1/4 / 36 3/4
LS 2 1/4 / 36 1/4
LT 2 1/4 / 35 1/4
MS-x / 36 1/4
MT-x / 35 1/4
Top of Tie
FT-x / 19 3/4
Top of Tie
2 1/2
2 1/4
1
ROLLING EQUIPMENT with maximum wear, loading and deflection when on track curves of 800 ft. radius must be within this line
On curves of less radii than 800 feet and at switches, equipment must be within this line
THIRD RAIL STRUCTURES must be within this line on tangents and on all curves having radii greater than 800 feet
On curves of less radii than 800 feet and at switches, third rail structures must be within this line
NOTE: When local speed and track conditions make it desirable, the third rail structures may be moved out on curves having radii greater than 800 feet up to maximum shown by this line
On curves of less radii than 800 feet and at switches these lines must be moved out 2 1/4 inches.
24 in. to gauge line
25 in.
20 1/4 in.
6 1/4
18 1/4
Plane of top of both running rails
19 3/4 in.-to-gauge-line
10

Recommended Standard Design for Limiting Clearance Lines for Third-Rail and Permanent Way Structures and Rolling Equipment.

tion in joint conference with our own Committee and, therefore, no definite recommendation can be made in regard to this at the present time.

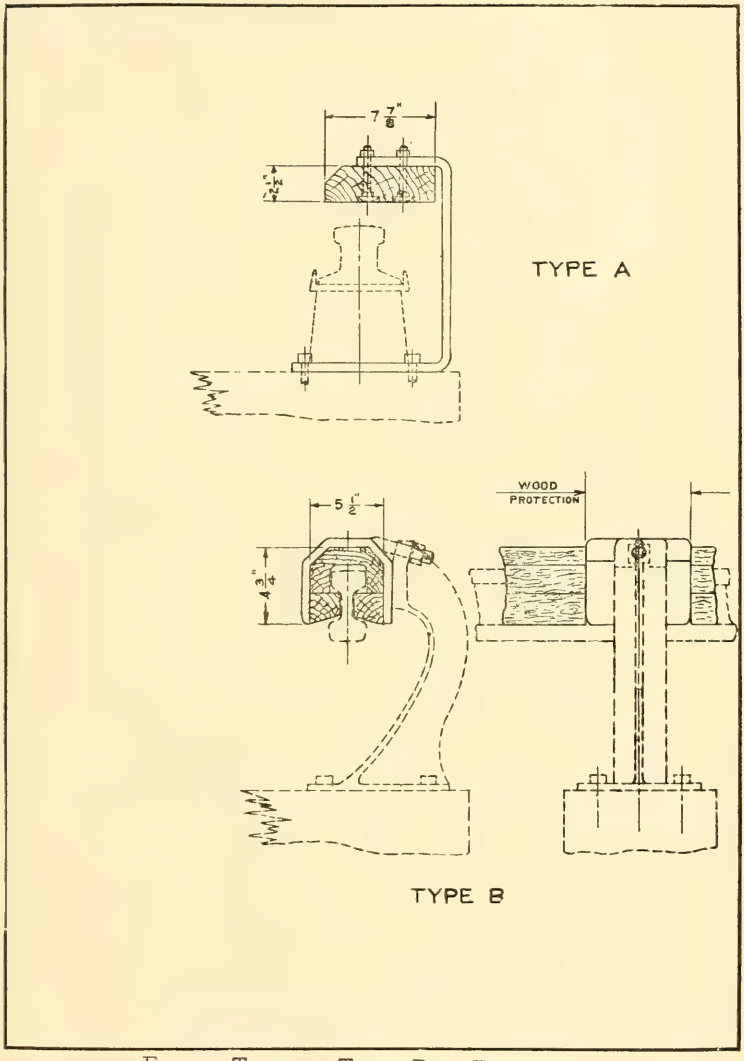


FIG. 2. TYPES OF THIRD RAIL PROTECTION.

DEFINTION OF THIRD-RAIL GAUGE

The Committee recommends that the Standard Definition of third-rail gauge be fixed as follows:

Distance measured parallel to plane of top of both running rails between gauge of nearest running rail and inside gauge line of third rail.

This is the definition adopted by the American Railway Association and the American Railway Engineering Association.

PROTECTION OF CONTACT RAIL WHERE PROTECTED THIRD-RAIL IS USED

The Committee has not considered nor is it understood that it has been asked to report on the question of whether or not protection should be provided for third-rail when used for heavy electric traction purposes as both protected and unprotected third-rail is in use at the present time in various parts of the country. Where Member Companies using third-rail desire to protect it in some manner both against accidental contact and from sleet and ice the Committee considers that either of two types of protection will be found suitable and may be used to advantage. These two types are shown on Fig. 2, Type "A" being used for top contact third-rail and Type "B" for under-running type of third-rail. These two types of protection represent the latest and best practice as established by roads using the two types of third-rail indicated. The Committee's recommendation on this subject, therefore, is that Type "A" third-rail protection be adopted as a Recommended Design for use in connection with top contact third-rail and that Type "B" third-rail protection be adopted as a Recommended Design where under-running third-rail is used.

STUDY OF MODERN ELECTRIC LOCOMOTIVES

The Committee understands that in assigning this subject the Executive Committee desires to present to the Association available data regarding general types of electric locomotives used by railroads that have adopted electric traction for the operation of their trains. To this end the Committee has collected and compiled the data herein presented. It has been thought advisable to limit the present study to the practice on electrified steam railroads and on lines acquired or owned by steam railroads. The tabulated data, therefore, does not cover locomotives used on interurban lines or those used for switching in industrial plants, mining operations, etc.

The principal data obtained from the various railroads using electric locomotives has been compiled in the form of two tables, namely

Table A — Locomotives used on domestic railways.
Table B — Locomotives used on foreign railways.

The tables give under each railroad the number of locomotives in use, description of the service, system of traction and voltage, kind of contact conductor employed, wheel arrangement, total weight and

weights of parts, horsepower rating, speed, type of drive and connection, and principal dimensions. The information given in the table covering domestic railways is supplemented by drawings and illustrations showing more clearly the arrangement of parts. distribution of loads, etc., of the electric locomotives used on several of the large railroads. In connection with the table of foreign locomotives a few photographs have been inserted to show the various types.

Traction Systems

It is not within the province of this report to discuss systems of electric traction but it is interesting to note that practically all the available systems are represented in the tables. An analysis of the tables indicates that of a total of 319 domestic locomotives listed 113, or 35 per cent, are used in connection with 600-volt d-c. third-rail operation, the remaining 206, or 65 per cent, being used in connection with some form of overhead trolley, and that of the locomotives using overhead trolley 66 per cent are in connection with alternating current systems. It will be noted that the foreign locomotives except those in England and France operate in connection with some form of overhead trolley.

Forced Ventilation

In regard to the electrical equipment the practice of using forced ventilation is becoming quite general especially where alternating current or high voltage direct current equipments are used. There is a distinct weight and cost economy resulting from the use of forced ventilation which more than justifies the provision and maintenance of the blowing apparatus. In the case of the Pennsylvania Terminal locomotives where forced ventilation is not used at present for the short haul, service provisions have been made for adding forced ventilation and thus materially increasing the motor capacity when required later on in connection with extensions. The later type New York Central locomotives are equipped with forced ventilated motors.

The most interesting features which develop from a study of electric locomotives is the design of the mechanical parts, especially the wheel arrangement and the method of drive. It will be seen from an examination of the tables and drawings that there is a great divergence of practice in regard to these features. Where locomotives are used for high speed operation leading and trailing wheels are provided by a majority of the roads and in some cases even where the speeds are low and where the line contains numerous track curves it has been thought advisable to provide trucks for leading the locomotives into and out of curves and to prevent oscillation and excessive side pressure on track rails. The majority of foreign locomotives use two-wheel trucks. The latest type of New York Central locomotive has the guiding trucks equipped with motors.

Method of Drive

Probably the greatest amount of ingenuity and effort in developing the design of electric locomotives has been devoted to the question of type or method of connection between the motor shaft and the axles. A very considerable portion of the weight of the electrical equipment is in the motors and to carry these satisfactorily they should as far as possible be spring supported, either by mounting them on the main locomotive frames or on a separate system of springs. The relation, however, between the motor shaft and the axle must be definitely maintained and at the same time it is important to provide flexibility and cushioning of the motor weight.

It will be seen from the tables that there are four distinct types of connections between motor and driving wheels, namely:

(*a*) *Motors mounted directly on the axles and connected either rigidly or by means of spring or quill connections to the driving wheels:* Where the complete motors are mounted rigidly on the axles it is obviously impossible to carry the motors on springs. The New York Central locomotive motors are bi-polar and gearless, and the armatures only are mounted on the axles, the remainder of the motor being attached to and carried by the locomotive frames. The earlier New Haven locomotives had the motors mounted on quills with a relatively small amount of movement provided for in the spring drive.

(*b*) *Motors geared to the axles either directly or through quills and driving springs:* Until comparatively recently the usual practice has been to gear the motors directly to the axles and there are numerous examples such as the Baltimore and Ohio, Grand Trunk, Michigan Central, and others. The later New Haven locomotives are examples of the use of motors geared to quills and provided with flexible spring drive between quills and wheels. Where the motors are geared directly to the axles the motors are usually suspended at the same level as the axles and geared horizontally to them, part of the weight of the motor being carried on the locomotive frame which in turn is flexibly supported by the main locomotive springs. There is practically no flexibility transversely with this method of mounting. Where the motors are geared to quills around the driving axles the entire weight of the motors and gears is carried on springs but the amount of flexibility both vertically and horizontally is restricted by the relatively small clearances that are permissible with this arrangement.

(*c*) *Motors geared to jackshafts which are in turn connected to the driving wheels by means of side rods:* In this case the motors with gears and jackshafts are all mounted on the main frames and hence are spring supported and the connection between the jackshafts and drivers is affected by means of side rods with the maximum amount

Company No.
1
2
3
1
1
1
1
1
5

TABLE A — ELECTRIC LOCOMOTIVES AMERICAN LINES

Company No.	Railroad	Key No.	Series No.	Number in service	Year placed in service	Class of service	System of traction	Contact conductor: Voltage	Contact conductor: Type	Classification	Driving wheels: No.	Driving wheels: Diam.	Truck wheels: No.	Truck wheels: Diam.	Weights: Total	Weights: On drivers	Weights: Per driving axle	Weights: Mechanical parts	Weights: Electrical parts	Dimensions: Length over all	Dimensions: Width over all	Dimensions: Height rail to highest point	Wheel bases: Rigid	Wheel bases: Total	Motors: No.	Motors: Type	Motors: H.P. 1 hour rating with forced ventilation	Motors: Method of hanging	Motors: Gear ratio	Hour power of locomotive with forced ventilation: Maximum tractive effort, lbs. — Corresponding speed, m.p.h.	Hour power of locomotive with forced ventilation: Continuous tractive effort, lbs. — Corresponding speed, m.p.h.	Speed—Mph: 1 hr. rating	Speed—Mph: Continuous rating	Speed—Mph: Hour rating	Speed—Mph: Maximum test	Key No.
															(Pounds)	(Pounds)	(Pounds)	(Pounds)	(Pounds)																	
	New York Central	1-a		47	1906-09	Passenger	D.C.	600	Third rail	4-8-4	8	44"	8	36½"	244,500	148,500	37,250			43' 0½"	10' 0"	14' 8"	13' 0"	38' 6"	4	G.E. 84	300	Direct		21,900 — 15.00	15,600 — 23.00	2,200	1,800	38.5	80	1-a
		1-b	T-1	10	1913	Passenger	D.C.	600	Third rail	4-4-4-4	10	36"	0	0	237,000	237,000	29,625			55' 2"	10' 0"	14' 8"	6' 0"	45' 7"	8	G.E. 92	275	Direct		17,200 — 11.00	11,400 — 23.00	2,650	1,700	60.5	85	1-b
		1-c	T-2	6	1914	Passenger	D.C.	600	Third rail	4-4-4-4	10	36"	0	0	268,000	265,000	33,125			56' 10"	10' 0"	14' 8"	6' 0"	46' 5"	8	G.E. 91	325	Direct		20,000 — 11.00	14,400 — 23.00	3,000	2,000	49.0	85	1-c
2	Pennsylvania	2		31	1910	Passenger	D.C.	600	Third rail	4-4-4-4	8	72"	8	36"	312,000	205,000	51,250	193,000	119,000	64' 11"	11' 8½"	14' 8½"	7' 2"	55' 11"	2	W. 313-A	1,000	Side rod		21,000 — 15.00	15,000 — 23.00	12,000	11,860	44.5	80	2
3	New York, New Haven & Hartford	3-a	01-031	41	1907	Passenger	S.P.D.C.	11,000-22,000	Cat. & rail	2-4-4-2	8	62"	4	33"	260,000	162,000	40,500	94,000	112,000	57' 2"	10' 2"	14' 1"	8' 0"	36' 0"	4	W. 130	335	Direct		9,700	6,400	1,700	1,175	54.5	88	3-a
		3-b	080	1	1910	Passenger and freight	S.P.D.C.	11,000-22,000	Cat. & rail	2-8-2	8	63"	4	36"	232,000	176,000	44,000	111,460	120,600	48' 8"	10' 3"	14' 2"	11' 0"	39' 0"	4	W. 308 A	1,400	Geared	22.67	17,700	12,200	1,300	1,154	36.0	54	3-b
		3-c	070	1	1910	Freight and switching	S.P.D.C.	11,000-22,000	Cat. & rail	2-4-4-2	8	55"	4	30"	260,000	182,000	45,725	137,400	127,000	52' 0"	10' 3"	14' 3"	8' 6"	34' 0"	2	W. 306	1,620	Side rod		16,700	12,000	1,240	1,044	32.0	61	3-c
		3-d	071	1	1910	Passenger and fast freight	S.P.D.C.	11,000-22,000	Cat. & rail	2-4-4-2	8	63"	4	42"	273,000	183,000	45,750	144,000	129,000	48' 0"	10' 3"	14' 2"	7' 0"	38' 0"	4	W. 303	1,335	Geared	14.73	13,200	11,500	1,250	1,100	37.0	54.5	3-d
		3-e	075	1	1911	Passenger and fast freight	S.P.D.C.	11,000-22,000	Cat. & rail	2-4-4-2	8	63"	4	42"	298,000	183,000	46,000	146,200	128,800	48' 0"	10' 3"	14' 2"	7' 0"	38' 0"	4	W. 303	1,335	Geared	14.73	13,200	11,800	1,500	1,400	37.0	54.5	3-e
		3-f	073-075	3	1912	Passenger	S.P.D.C.	11,000-22,000	Cat. & rail	2-4-4-2	8	63"	4	36"	310,000	182,000	45,500	173,000	115,100	50' 1"	10' 3"	14' 3"	8' 0"	40' 1"	4	W. 306	1,620	Geared	22.62	17,700	12,200	1,300	1,164	36.0	54	3-f
		3-g	079-0111	36	1911	Freight and switching	S.P.	11,000	Cat. & rail	2-4-4-2	8	63"	4	36"	220,000	165,000	41,250	121,400	98,600	50' 2"	10' 3"	14' 3"	8' 0"	40' 1"	8	W. 308 C	1,750	Geared	22.62	17,700	12,200	1,300	1,164	36.0	54	3-g
		3-h	1201	1	1911	Switcher	S.P.	11,000	Cat. & rail	0-4-4-0	8	63"	0	0	158,800	158,000	39,500	79,700	78,300	37' 0"	10' 0"	14' 2"	7' 0"	25' 6"	4	W. 310	188	Geared	17.101	23,200	14,800	752	400	10.0	25	3-h
		3-i	0231-0234	15	1912	Switcher	S.P.	11,000	Cat. & rail	0-4-4-0	8	63"	0	0	159,200	159,200	39,800	83,400	75,800	37' 0"	10' 0"	14' 2"	7' 0"	25' 6"	4	W. 310	188	Geared	17.101	23,200	14,800	752	400	10.0	25	3-i
		3-j	0215	1	1912	Switcher	S.P.	11,000	Cat. & rail	0-4-4-0	8	63"	0	0	154,700	154,700	38,675	83,800	71,200	37' 0"	10' 0"	14' 2"	7' 0"	25' 6"	4	W. 310	188	Geared	17.101	23,200	14,800	752	400	10.0	25	3-j
4	Pere Marquette & Reading	4-a	46-60	15	1913	Freight	D.C.	2,400	Catenary	0-4-4-0	8	56"	0	0	112,000	102,000	40,500	100,000	62,000	37' 4"	10' 0"	13' 6"	8' 8"	26' 0"	4	G.E. 223 A	400	Geared	33.13	30,600	25,000	1,280	1,090	15.4	35	4-a
		4		2	1913	Passenger	D.C.	2,400	Catenary	0-4-4-0	8	80"	0	0	160,000	160,000	40,000	110,000	60,000	37' 4"	10' 0"	13' 6"	8' 8"	26' 0"	4	G.E. 220 A	340	Geared	30.25	29,200	16,200	1,280	1,090	23.4	50	4-b
5	Norfolk & Western	5	1500-01	12	1915	Freight	S.P.	11,000	Catenary	2-4-4-2 2-4-4-2	16	62"	8	30"	540,000	448,000	56,000	521,000	219,000	105' 8"	11' 0½"	16' 0"	11' 0"	93' 10"	8	W. 450 A	1,410 1,450	Geared (side rod)	18.85	387,000 at 11.0 344,000 at 12.5	268,000 at 23.0 240,000 at 25.0	2,000 3,000	14.0 28.0	35	5
6	Pennsylvania	6-a		5	1905-06	Freight	D.C.	600	Third rail	0-8-0	8	42"	0	0	170,000	160,000	40,000	110,000	44,000	29' 7"	8' 6"	13' 8"	11' 6½"	13' 6½"	4	G.E. 65 B	200	Geared	84.16	46,000		500	8.0		6-a
		6-b	71-72	2	1910	Passenger and freight	D.C.	600	Third rail	0-4-4-0	8	50"	0	0	185,000	185,000	46,250	119,000	66,000	34' 6"	10' 2"	14' 5"	9' 0"	27' 0"	4	G.E. 269	250	Geared	78.24	24,500	12,250	1,120	660	16.5	45	6-b
		6-c	13-14	2	1912	Passenger and freight	D.C.	600	Third rail	0-4-4-0	8	50"	0	0	200,000	200,000	50,000	135,000	65,000	34' 6"	10' 2"	14' 5"	9' 0"	27' 0"	4	G.E. 269	280	Geared	78.24	24,500	12,250	1,120	660	16.5	45	6-c
7	Michigan Central	7-a		6	1900	Passenger and freight	D.C.	600	Third rail	0-4-4-0	8	48"	0	0	200,000	200,000	50,000	135,000	65,000	39' 6"	10' 2½"	15' 5"	9' 0"	27' 0"	4	G.E. 203 A	275	Geared	84.19	34,700	17,000	1,160	660	11.8	40	7-a
		7-b		4	1911	Passenger and freight	D.C.		Third rail	0-4-4-0	8	48"	0	0	240,000	240,000	60,000	175,000	65,000	39' 6"	10' 2½"	15' 5"	9' 0"	27' 0"	4	G.E. 203 B	275	Geared	83.19	33,000	17,000	1,160	660	12.1	40	7-b
		8	5000-4	5	1911	Passenger and freight	S.P.	11,000	Catenary	2-4-4-2	8	63"	4	42"	250,000	204,000	51,000	141,800	113,200	48' 0"	10' 3"	14' 5"	7' 0"	38' 0"	4	W. 303 A	375	Geared	32.01	23,300	20,500	1,500	1,400	20.0	30	8
9	Great Northern	9	5000-14	3	1913	Passenger and freight	S.P.	11,000	Catenary	0-4-4-0	12	62"	0	0	264,000	264,000	44,000	147,200	116,800	55' 0"	9' 8"	14' 11"	10' 0"	44' 11"	6	W. 137	330	Geared	19.88	52,210	37,000	1,500	1,335	10.8	30	9
10	Great Northern	10	5000-3	4	1909	Passenger (electric-gasoline)	S.P.	11,000	Catenary (electric-gasoline)	0-4-4-0	8	80"	0	0	230,000	230,000	57,500	121,000	109,000	44' 2"	10' 0"	14' 2"	11' 6"	33' 2"	4	G.E. 500	375	Geared	81.19	37,200	34,800	1,500	1,480	15.2	30	10
11	Great Northern	11	5000-5	6	1909	Passenger and freight	D.C.	2,400	Catenary	0-4-4-0	8	80"	0	0	190,000	190,000	47,500	103,540	93,490	37' 4"	10' 0"	13' 6"	8' 8"	26' 0"	4	G.E. 229 A	340	Geared	80.25	29,200	14,500	1,280	984	21.6	50	11
12	Baltimore & Ohio	12-a	M-1 M-6	6	1906	Freight	S.P.D.C.	11,000	Catenary	0-4-4-0	8	56"	0	0	140,000	100,000	25,000	81,700	58,300	21' 03"	9' 0"	11' 0"	7' 0"	21' 1"	4	W. 133	150	Geared	15.74	13,250	17,200	600				12-a
		12-b	M-7 M-11	5	1907-10	Freight	S.P.D.C.	11,000	Catenary	0-4-4-0	8	56"	0	0	144,000	144,000	36,000	75,600	68,400	48' 5"	9' 7½"	12' 2"	9' 0"	24' 10"	4	W. 151	175	Geared	17.70	23,800	14,725	700				12-b
13	Chicago, Milwaukee & St. Paul	13-a		30		Freight	D.C.	3,000	Catenary	2-6-6-2 + 2-4-4-2	16	52"	8	36"	550,000	420,000	52,500	321,200	225,100	112' 1"	10' 0"	16' 5"	11' 6"	102' 8"	8	G.E. 253 A	430	Geared	82.18	85,000	71,000	3,440	3,000	15.25	35	13-a
		13-b		12		Passenger	D.C.	3,000	Catenary	2-6-6-2 + 2-4-4-2	10	52"	8	36"	500,000	400,000	57,500	324,000	265,100	112' 1"	10' 0"	16' 5"	11' 6"	102' 8"	8	G.E. 253-A	430	Geared	71.29	45,000	28,000	3,440	3,000	28.30	65	13-b
14	Virginian	14	01	1	1912	Switcher	S.P.	11,000	Catenary	2-4-4-2	8	63"	0	0	159,200	159,200	39,800	83,400	75,800	37' 0"	10' 0"	14' 2"	7' 0"	23' 0"	4	W. 310	188	Geared	17.101	23,200	14,800	752	400	10.00	25	14

Key: Type of service: P = Passenger, F = Freight, S = Switcher. System of traction: D.C. = Direct current, S.P. = Single phase. Type: Cat. & rail = Catenary and third rail. Classification: 2-4-4-2 = 2 leading, 4 driving, 4 trailing, 2 trailing wheels. Weights: Total = Total weight of locomotive; On drivers = Weight on driving wheels; Per driving axle = Weight per driving axle; Mechanical parts = Weight of mechanical parts; Electrical parts = Weight of electrical parts. Dimensions: Length over all = Length over all; Width over all = Width over all; Height rail to highest point = Height rail to highest point. Wheel bases: Rigid = Rigid wheel base; Total = Total wheel base. Motors: No. = Number of motors; Type = Type of motor; H.P. 1 hour rating with forced ventilation = H.P. 1 hour rating with forced ventilation; Method of hanging = Method of hanging motors; Gear ratio = Gear ratio. Hour power of locomotive with forced ventilation: Maximum tractive effort, lbs. — Corresponding speed, m.p.h. = Maximum tractive effort, lbs. — Corresponding speed, m.p.h.; Continuous tractive effort, lbs. — Corresponding speed, m.p.h. = Continuous tractive effort, lbs. — Corresponding speed, m.p.h. Speed—Mph: 1 hr. rating = 1 hr. rating; Continuous rating = Continuous rating; Hour rating = Hour rating; Maximum test = Maximum test. Key No. = Key No.

560 (a)

TABLE B ELECTRIC LOCOMOTIVES—EUROPEAN LINES

Compan. No.	Railroad	Key No.	Number in series	Year placed in service	Class of service	System of traction	Contact conductor: Voltage	Contact conductor: Type	Driving wheels: Wheel arr.	Driving wheels: No.	Driving wheels: Diameter	Truck wheels: No.	Truck wheels: Diameter	Weight: Total	Weight: On drivers	Weight: Mechan. part	Weight: Elec. part	Dimensions: Length over all	Dimensions: Width over all	Dimensions: Height rail to highest point	Wheel base: Rigid	Wheel base: Total	Motor: No.	Motor: H.P. one hour rating	Method of drive	Tractive effort Pounds One hour rating	Speed M.P.H. at one hour rating	Key No.
														(Pounds)	Pounds	(Pounds)	Pounds											
1	Metropolitan Railway, London	1-a	10	1905	Passenger and freight	D.C.	600	Third rail	0-4-4-0	8	36"	0	0	112,000	112,000	60,440	42,500	35' 0"	9' 0"	12' 3½"	7' 6"	17' 3"	4	1,250	Gearless	12,480	26.3	1-a
		1-b	10	1907	Passenger and freight	D.C.	600	Third rail	0-4-4-0	8	38"	0	0	105,280	105,280			33' 6"	8' 7"	12' 3½"	7' 6"	24' 6"	4	1,240	Gearless	15,000	19.5	1-b
2	North Eastern	2	2	1904	Freight	D.C.	600	Third rail	0-4-4-0	8	36"	0	0	125,440	125,440			37' 11"	8' 8"	11' 9"	6' 6"	27' 0"	4	1,240	Gearless	15,120	8.6	2
3	Baltimore	3-a	6	1908	Passenger	D.C.	600	Third rail	0-4-4-0	8	49"	0	0	110,000	110,000	60,380	49,620	34' 10"		13' 5"	7' 10"	23' 10"	4	225	Gearless	23,000	13.2	3-a
		3-b	3	1908	Passenger	D.C.	600	Third rail	0-4-4-0	8	49"	0	0	121,000	121,000	80,300	40,700	34' 10"		13' 5"	7' 10"	23' 10"	4	225	Gearless	25,000	13.2	3-b
		3-c	1	1908	Passenger	D.C.	600	Third rail	0-4-4-0	8	49"	0	0	121,000	121,000	80,300	40,700	34' 10"		13' 5"	7' 10"	23' 10"	4	225	Gearless	25,000	13.2	3
		3-d	6			D.C.	600	Third rail						180,200											Shaft	31,360		3-d
4	Detroit-Butler	4-a	6	1911		S.P.	15,000	Catenary	2-6-2	6	48½"	4	32 8"	158,400	105,600	85,800	72,600	41' 0"			15' 3"	34' 0"	1	1,100	Side rod		36	4-a
		4-b	2	1911	Passenger and freight	S.P.	15,000	Catenary	2-8-2	8	45 5"	4	33 4"	202,000	132,000			42' 0"		15' 6"	18' 4"	38' 8"	2	1,250	Side rod	11,800	43	4-b
		4-c	1	1911	Passenger	S.P.	15,000	Catenary	2-6-2	6	63"	4	39"	154,000	99,000	77,000	77,000	43' 0"			15' 3"	31' 5"	1	1,500	Side rod	30	4-c
		4-d	5	1911	Passenger	S.P.	15,000	Catenary	2-4-4	4	63"	6	39"	168,000	66,000	66,800	61,200	36' 10"	9' 11½"	13' 0"	9' 0"	20' 0"	1	1,000	Side rod	12,000	68.5	4-d
5	Baltimore-Philadelphia	5-a	2		Passenger	S.P.	15,000	Catenary	4-4-4	4	62"	8	38½"	154,000	66,000	85,800	68,200	46' 0"		14' 9"	6' 6"	33' 1"	1	1,250	Side rod		52	5
		5-b	13	Building	Freight	S.P.	15,000	Catenary	2-6+6-2	12	43½"	4	28½"	280,000				75' 4"		14' 0"		40' 1"	2	1,250	Side rod	13,200	22	5-b
6		6	40		Passenger and freight	3 phase	3,000	Catenary	0-10-0	10	42"	0	0	120,000	120,000	87,360	32,640	38' 5"				32' 8½"	2	1,000	Side rod	17,500	28	6
7	Paris-Orléans	7-a	14		Passenger and freight	S.P.	10,000	Catenary	2-4-2	4	41½"	4	27½"	72,600	46,200								1	300	Gearless	1,240	17.5	7-a
		7-b			Passenger and freight	S.P.	10,000	Catenary	2-8-2	8	41½"	4	27½"	111,400	88,000			33' 8"	8' 6½"			3' 0"	3	500	Gearless	17,600	17.5	7-b
8	Burgdorf-Thun	8-a	2	1899	Passenger and freight	3-phase	750	Catenary	0-4-0	4	48½"	0	0	66,000	66,000	43,120	22,880	25' 7"				10' 4"	2	150	Gearless	9,680	11.2	8-a
		8-b	3	1899	Passenger and freight	3 phase	750	Catenary	0-8-0	8	48½"	0	0	92,400	92,400	52,800	39,600	41' 2"				21' 0"	3	400	Gearless	17,304	20.1	8-b
9	Paris-Orléans	9	14	1911	Passenger	S.P.	15,000	Catenary	2-10-2	10	53"	4	33"	235,400	176,000	104,000	131,400	52' 6"			14' 9"	37' 0"	2	1,250	Side rods	20,700	31	9
10	Simplon Tunnel	10-a	4	1907	Passenger and freight	3-ph.	3,330	Catenary	2-6-2	6	64½"	4	33½"	136,000	96,500	74,800	61,200	40' 6"	9' 4"		16' 1"	31' 10"	2	450	Side rod	8,800	21.8	10-a
		10-b		1907	Passenger and freight	3 ph.	3,330	Catenary	0-8-0	8	49½"	0	0	150,000	150,000		70,000	34' 11"	9' 6"	12' 1"	15' 1"		2	850	Side rod	14,500	10.2	10-b
11	Mattmark	11	9	1912	Passenger and freight	S.P.	10,000	Catenary	2-6-0	6	40 7"	2	34 2"	160,000			53,600	29' 6"		13' 1½"	13' 1½"		1	500	Side rod	16,000	18.6	11
12	St. Polten-Mariazell-Gusswerk	12	10	1911	Passenger and freight	S.P.	6,500	Catenary	0-6-6-0	12	31½"	0	0	99,000	99,000		51,000	33' 9"	7' 6½"	16' 7"	7' 10½"		2	400	Geared wheel	15,400	17.3	12
13	Valtellina	13	13	1912	Passenger and freight	S.P.	10,000	Catenary	2-6-2	6	41 4"	4	33 5"	145,200	92,400		68,000	36' 5"	10' 4"	14' 5"	13' 1½"		2	475	Side rod	8,820	37.9	13
14	Valtellina	14-a	15	1902	Passenger and freight	3-phase	3,000	Catenary	0-8-0	8		0	0	92,000	92,000								4	150	Gearless	14,400	20	14-a
		14-b		1902	Passenger and freight	3-phase	3,000	Catenary	2-6-2	6	59 1"	4	31½"	124,000	84,000			37' 10"		12' 0"	15' 5"		2	600	Side rod	24,360	20	14-b
		14-c		1902	Passenger and freight	3-phase	3,000	Catenary	0-10-0	10		0	0	120,000	120,000								2	1,000	Side rod	19,500	14	14-c

500

Note.—The above data have been compiled from many sources, published and unpublished, and in view of the untertified and inexact character of not a few details it has not been possible for the committee to obtain data from the various operating companies or the manufacturers also owing to the different methods used by the various publishers of these data and possible inaccuracies due to translation, etc., it is suggested that the data above given be regarded as general information only.

[1] At one hour. [2] At 25 kilometers per hour.

of flexibility and this arrangement provides the same freedom of movement as is permissible and customarily provided in steam locomotives. The Norfolk & Western locomotives are an example of this type of drive.

(*d*) *Motors connected to jackshafts by means of main rods and drivers connected to jackshafts by means of side rods:* This arrangement has the same advantages as to flexibility of mounting and spring cushioning of motor weights as in the case of (*c*) above. It has been used in this country only for the Pennsylvania Terminal locomotives which are of the high speed passenger type and, therefore, rod connections were used between motors and jackshafts in preference to gears.

It is claimed by the users of motors mounted above the axles and connected either by gears or rods that improved riding qualities are obtained due to the high center of gravity of the locomotive as a whole, the tendency being for the heavier parts to roll on the springs and to reduce side pressure on the track rails. On the other hand, it is the opinion of those who use motors located on or near the axles, that the high center of gravity is not necessary to give good riding qualities provided the running gear is so designed as to avoid the setting up of an oscillatory tendency.

Axle Loading

Another interesting feature of electric locomotive practice as indicated by the tabulated data is the maximum weight per axle. On the domestic locomotives the weight per driving axle ranges with one exception, from 30,000 lb. in the case of the New York Central to 60,000 lb. in the case of the Michigan Central, the majority of locomotives having a weight of between 35,000 and 50,000 lb. on driving axles. It will be noted that this is considerably less than the axle weights used in steam locomotive practice where they range from 40,000 to 62,000 lb. and in some cases even as high as 68,000 lb. as in the case of the heaviest Pennsylvania engines.

Rigid Wheel Base

Another feature of the mechanical design of electric locomotives is the length of rigid wheel base, which for domestic locomotives ranges from 6 ft. 6 in. to 13 ft. (excepting a few B. & O. engines). In the majority of recent electric locomotives the rigid wheel base does not exceed 8 ft. with the exception of the Norfolk & Western where the rigid wheel base is 11 ft. This compares with a maximum of 14 ft. for steam passenger engines and 17 ft. 6 in. for steam freight engines.

Locomotive Capacity

Inasmuch as the source of power for the operation of electric locomotives is not on the locomotive itself but in the power house and lines connecting the power house with the locomotives, it is feasible to construct electric locomotives of almost unlimited power or capacity by providing a sufficient number of driving axles and motors. There is naturally a limit to the capacity which can be secured per axle on account of the limitations of track gauge and width and height of engines and on account of limitations in mechanical strength of materials used in the construction of the parts and restriction as to permissible weight per axle carried on the track. As an example of capacity may be cited the Norfolk & Western locomotive which consists of two units; two of these complete engines or four units will handle the same tonnage as three of the largest Mallet type of steam engines but at twice the speed.

Conclusion

In conclusion it may be said that electric locomotives have been built and operated to perform every kind of railroad service, that is, high speed and suburban passenger and road and yard freight up to and in excess of the maximum capacity for which steam locomotives have been built for similar service. It is, however, too early to attempt to standardize electric locomotives either electrically or mechanically.

Respectfully submitted,

E. B. Katté,
Hugh Hazelton,
W. S. Murray,
J. M. Bosenbury,
C. H. Quinn,
E. R. Hill, *Chairman,*
Committee on Heavy Electric Traction.

APPENDIX A

ILLUSTRATIONS OF AMERICAN LOCOMOTIVES

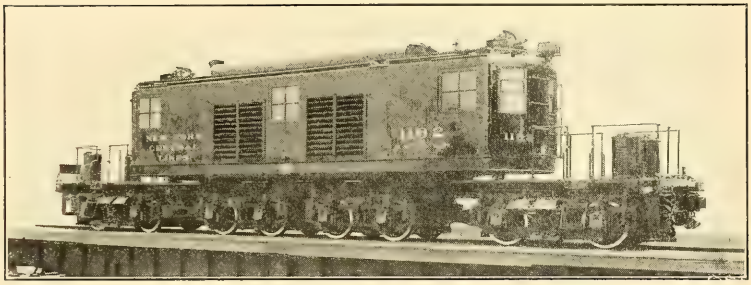


FIG. 1. NEW YORK CENTRAL RAILROAD.

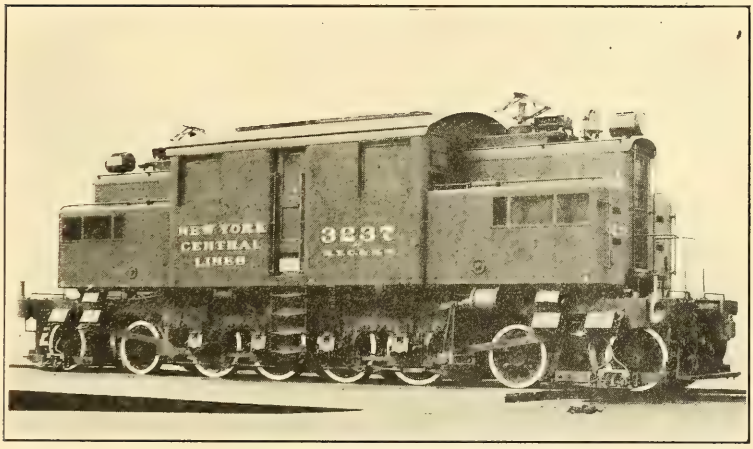


FIG. 2. NEW YORK CENTRAL RAILROAD.

FIG. 3. MICHIGAN CENTRAL RAILROAD.

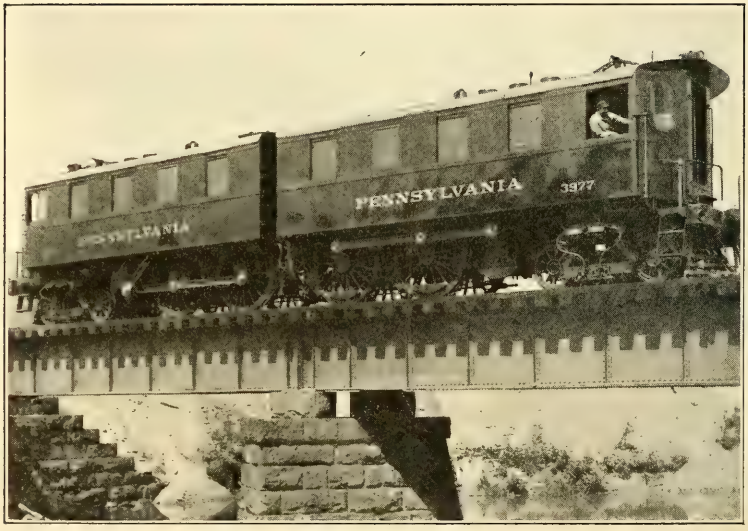


FIG. 4. PENNSYLVANIA RAILROAD.

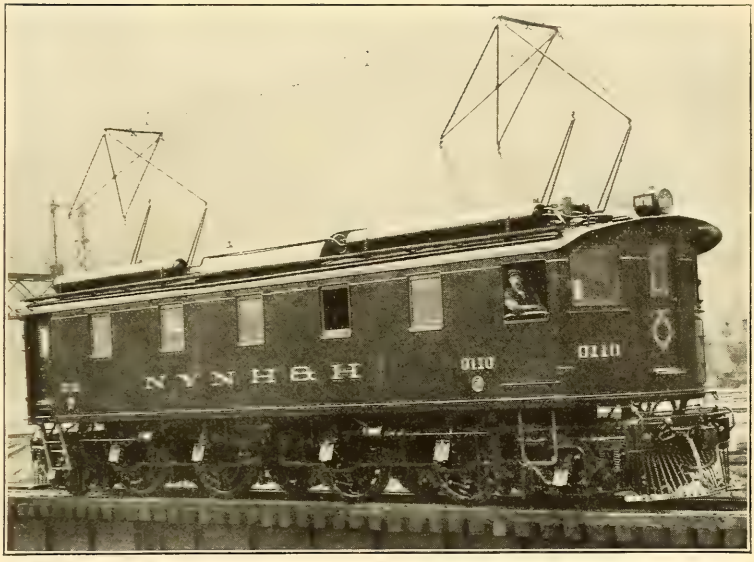


FIG. 5. NEW YORK, NEW HAVEN & HARTFORD RAILROAD.

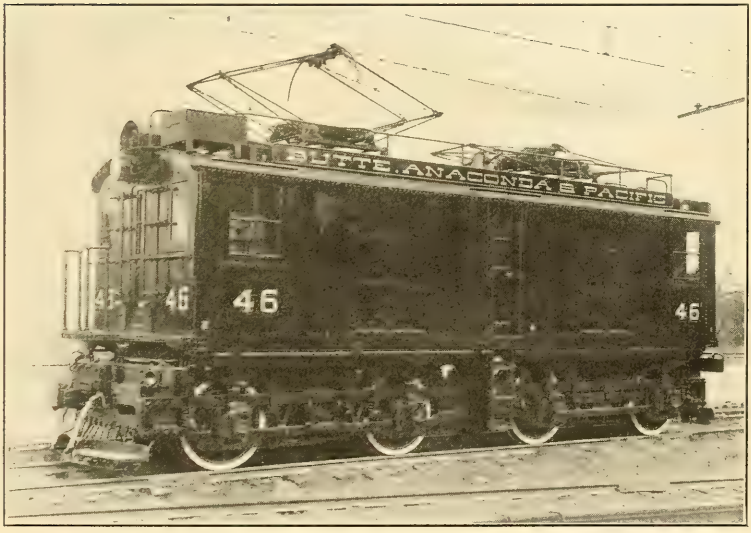


FIG. 6. BUTTE, ANACONDA & PACIFIC RAILROAD.

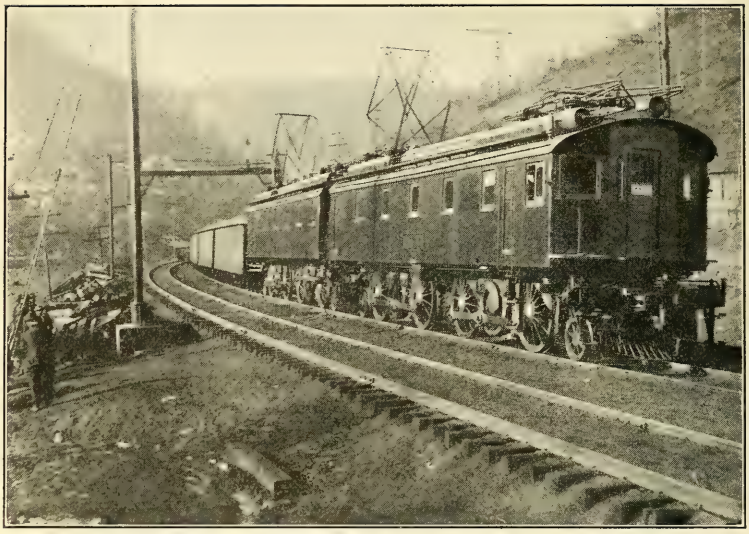


FIG. 7. NORFOLK & WESTERN RAILWAY.

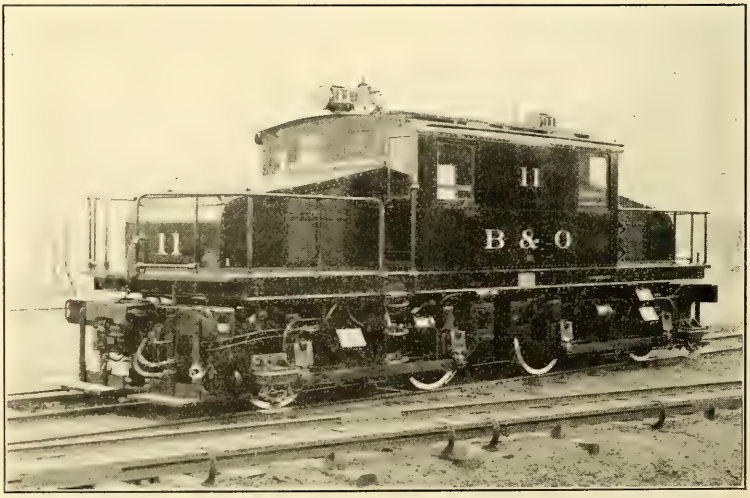


FIG. 8. BALTIMORE & OHIO RAILROAD.

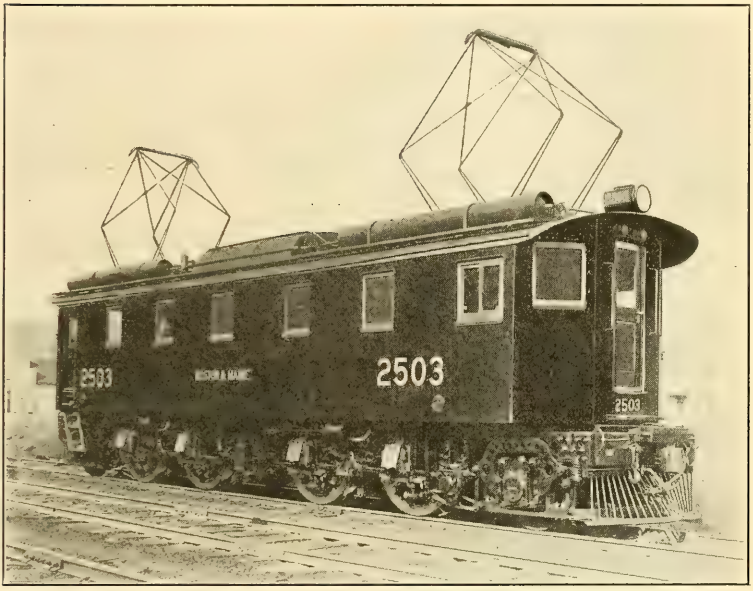


FIG. 9. BOSTON & MAINE RAILROAD.

FIG. 10. GRAND TRUNK RAILROAD.

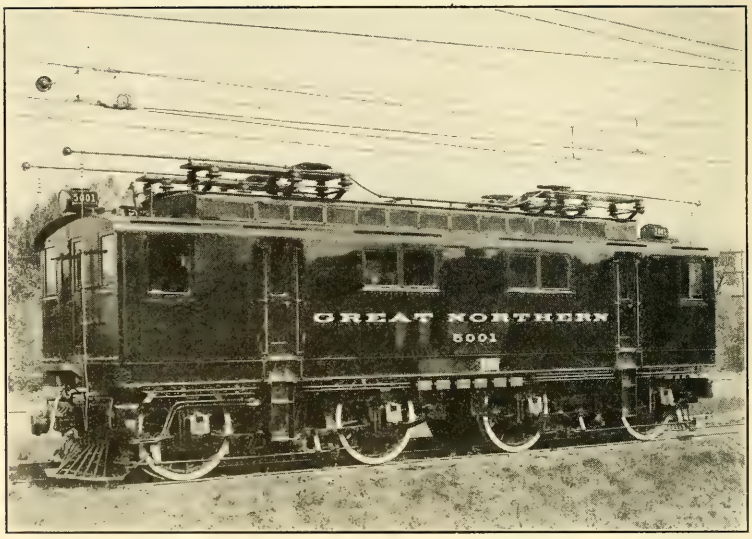


FIG. 11. GREAT NORTHERN RAILWAY.

FIG. 12. SPOKANE & INLAND EMPIRE RAILROAD.

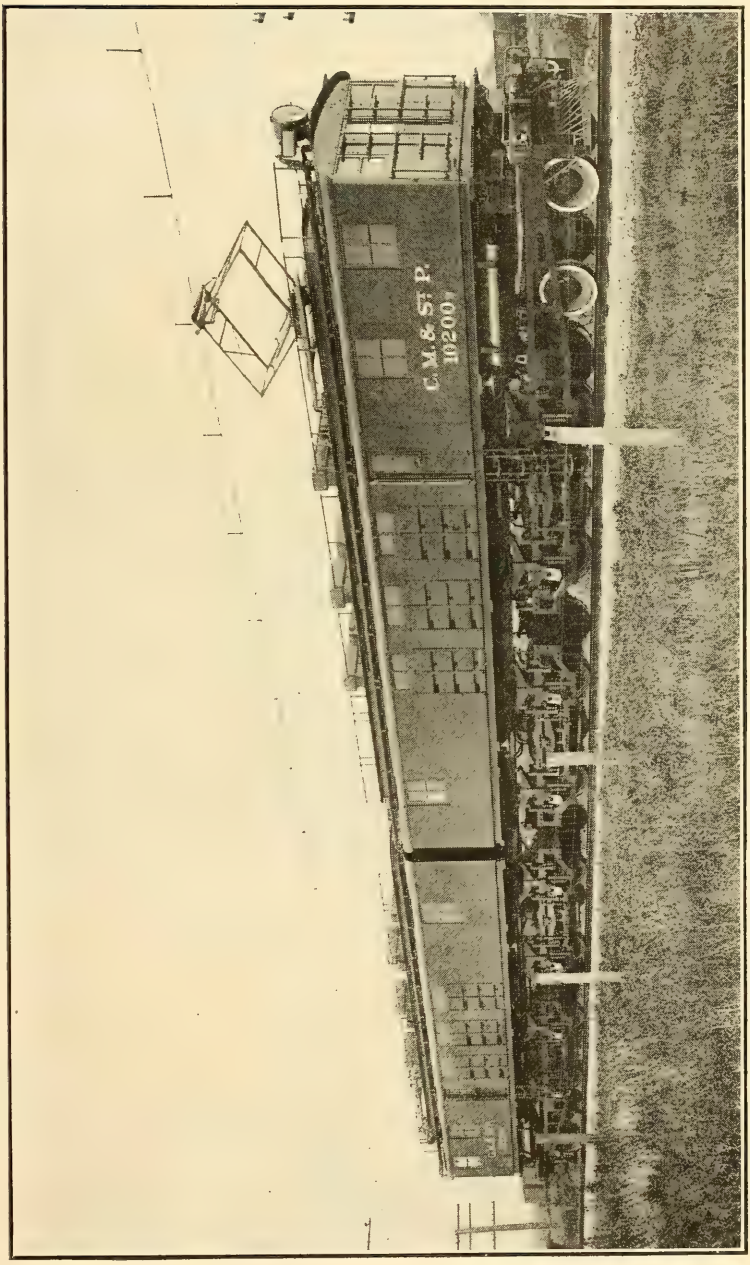


FIG. 13. CHICAGO, MILWAUKEE & ST. PAUL RAILROAD.

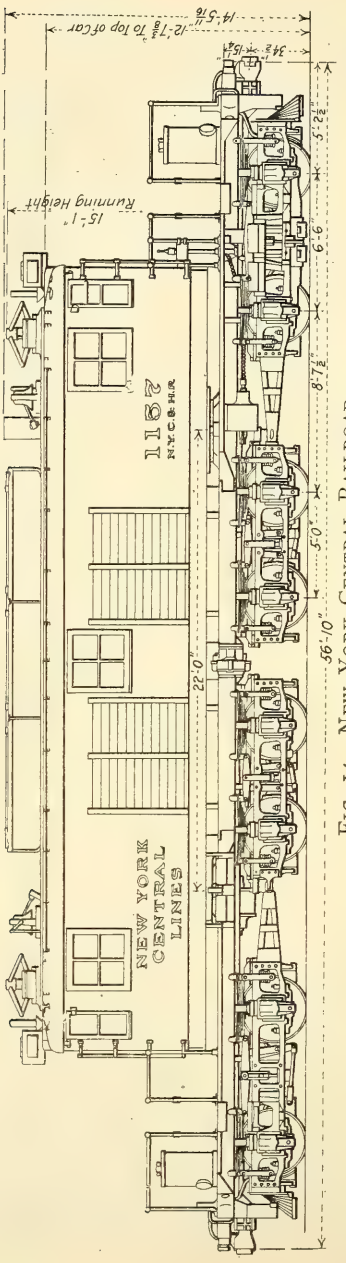


FIG. 14. NEW YORK CENTRAL RAILROAD.

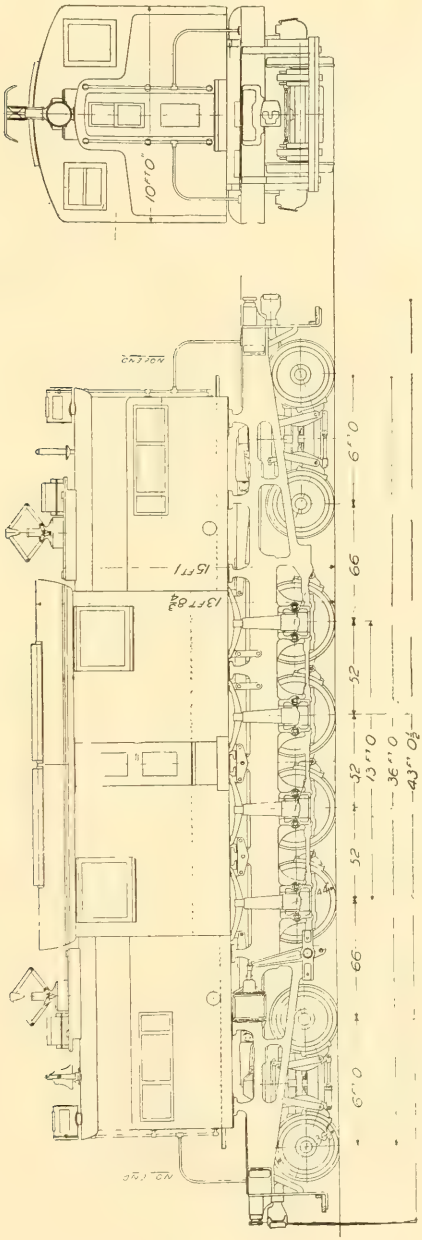


FIG. 15. NEW YORK CENTRAL RAILROAD.

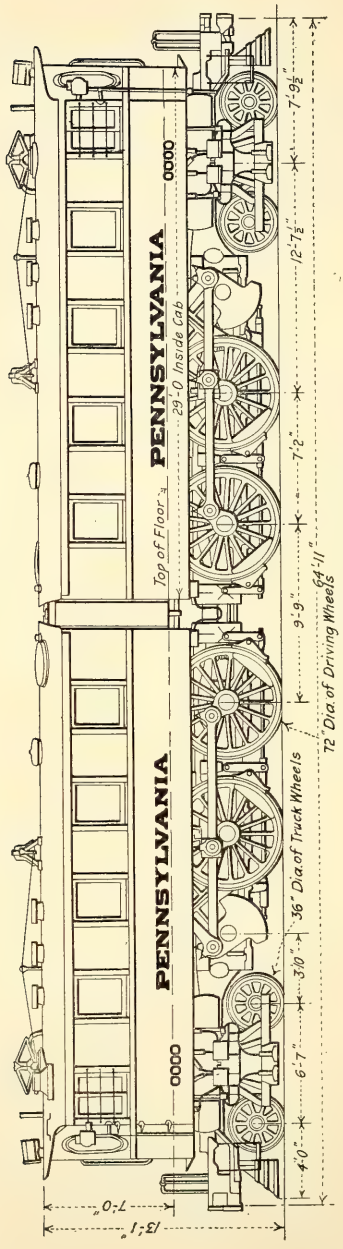


FIG. 16. PENNSYLVANIA RAILROAD.

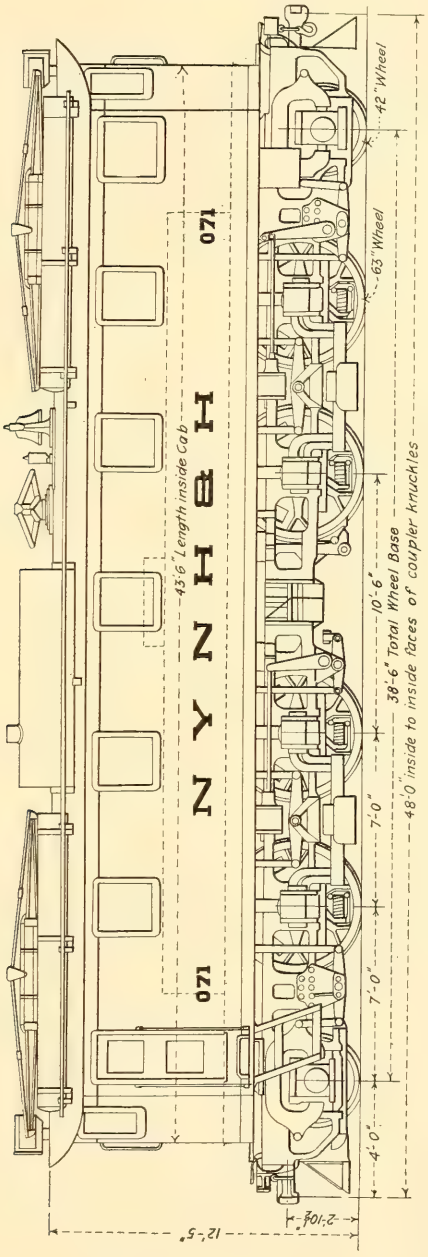


FIG. 17. NEW YORK, NEW HAVEN & HARTFORD RAILROAD.

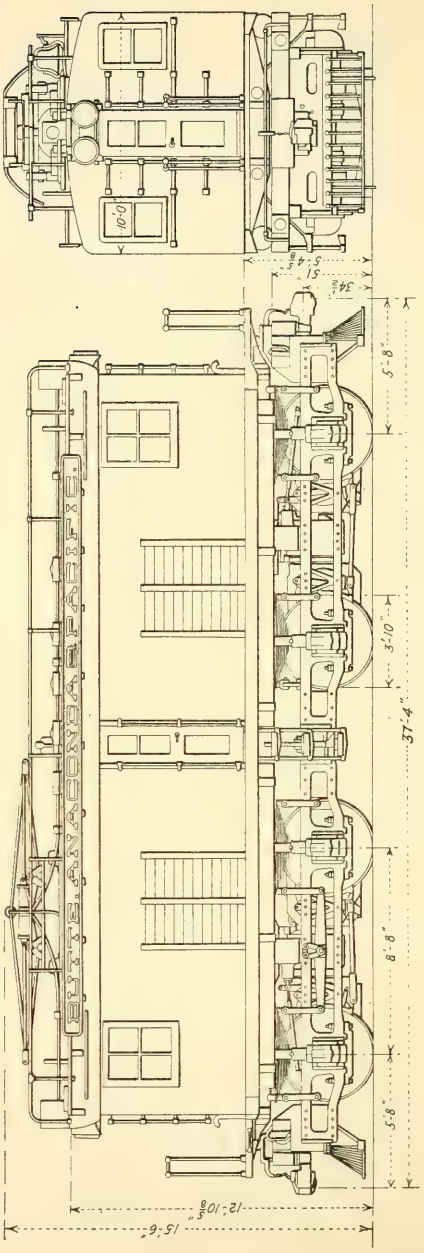


FIG. 19. BUTTE, ANACONDA & PACIFIC RAILROAD.

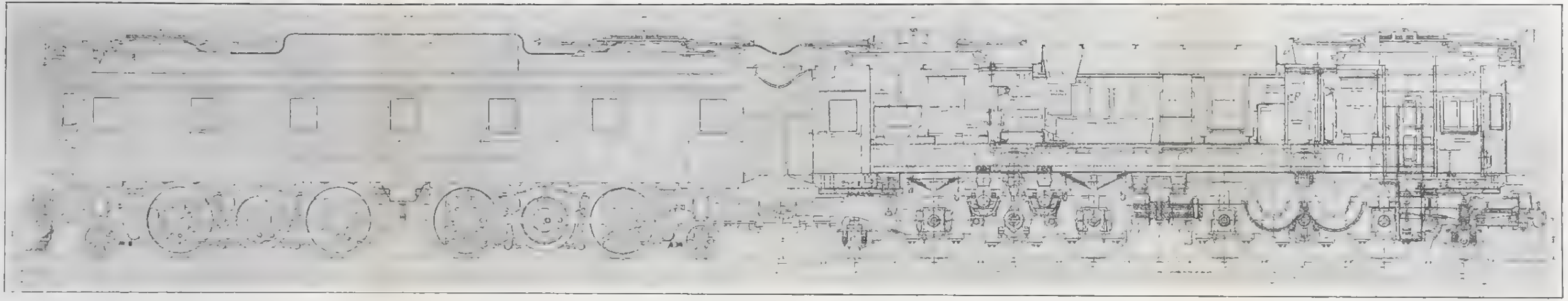


Fig. 18. Norfolk & Western Railroad

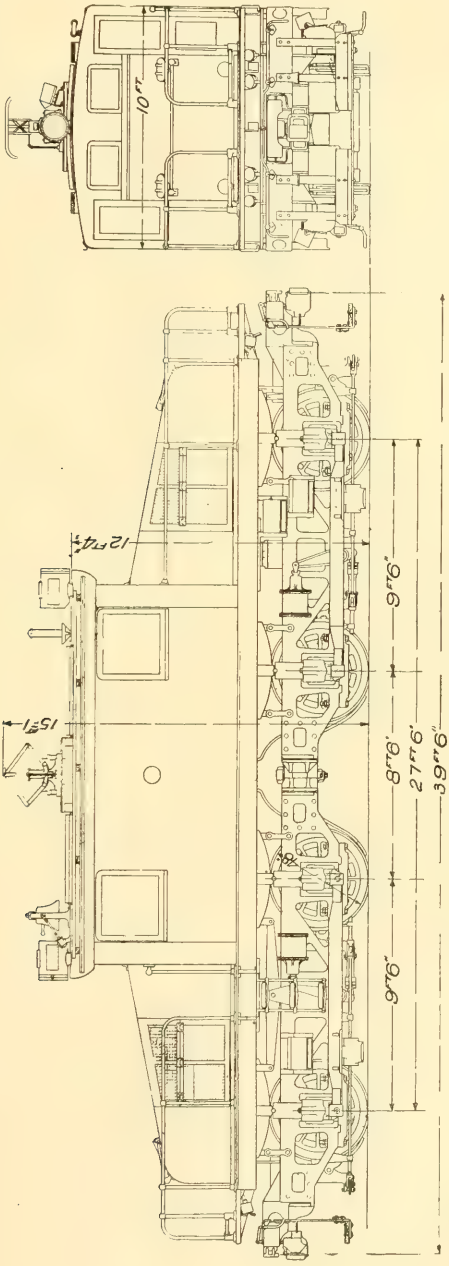


FIG. 20. BALTIMORE & OHIO RAILROAD.

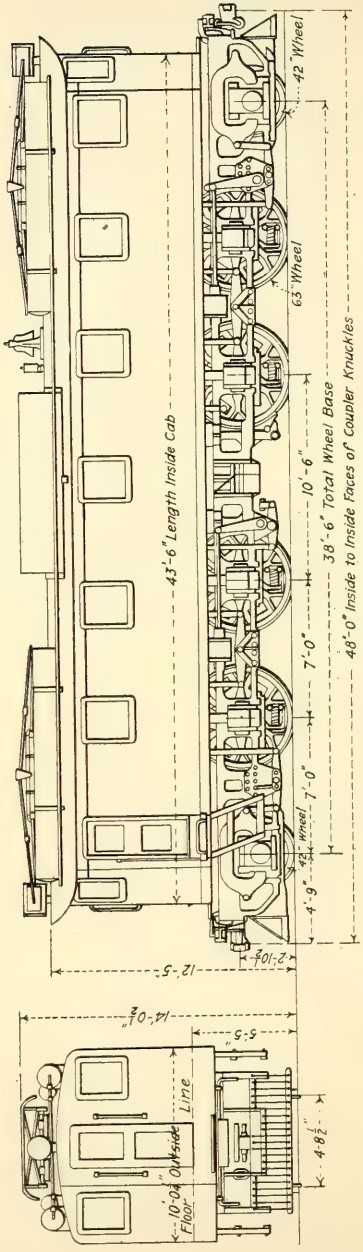


FIG. 21. BOSTON & MAINE RAILROAD.

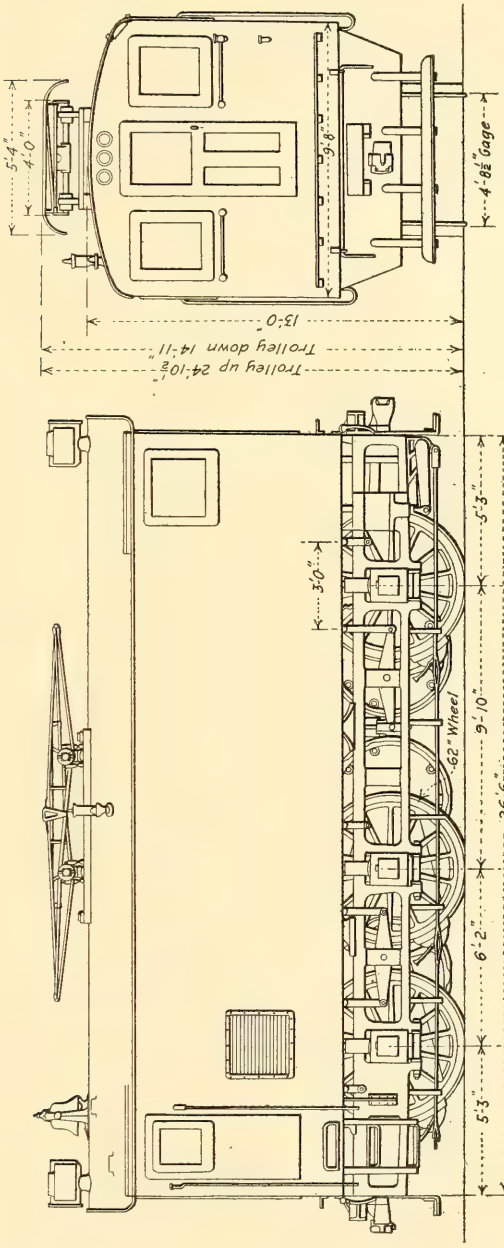


FIG. 22. GRAND TRUNK RAILROAD.

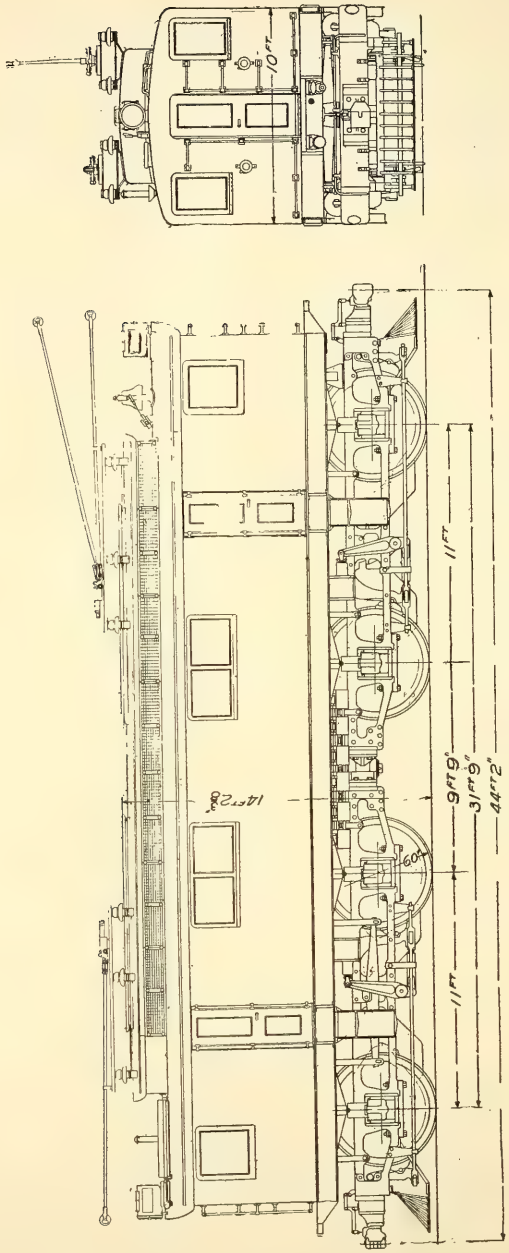


FIG. 23. GREAT NORTHERN RAILROAD.

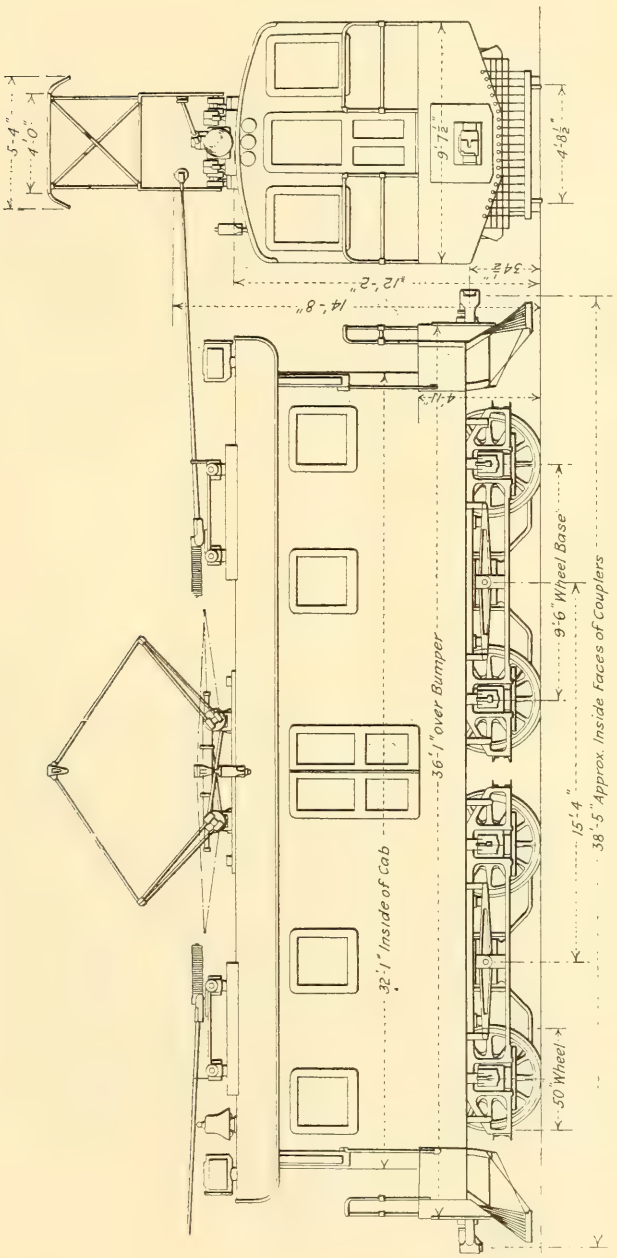


FIG. 24. SPOKANE & INLAND EMPIRE RAILROAD.

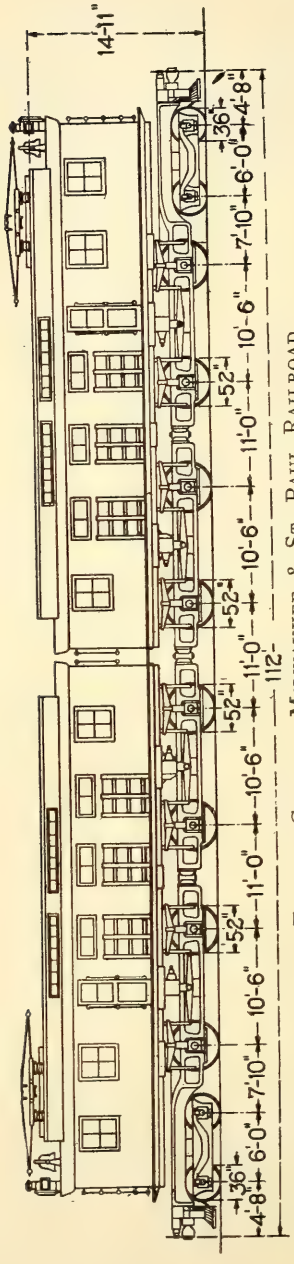


FIG. 25. CHICAGO, MILWAUKEE & ST. PAUL RAILROAD.

ILLUSTRATIONS OF FOREIGN LOCOMOTIVES

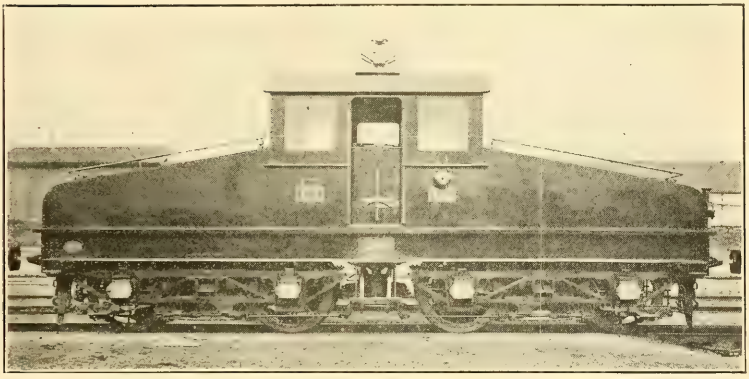


FIG. 26. PARIS–ORLEANS RAILWAY.

FIG. 27. DESSAU–BITTERFELD RAILWAY.

FIG. 28. DESSAU–BITTERFELD RAILWAY.

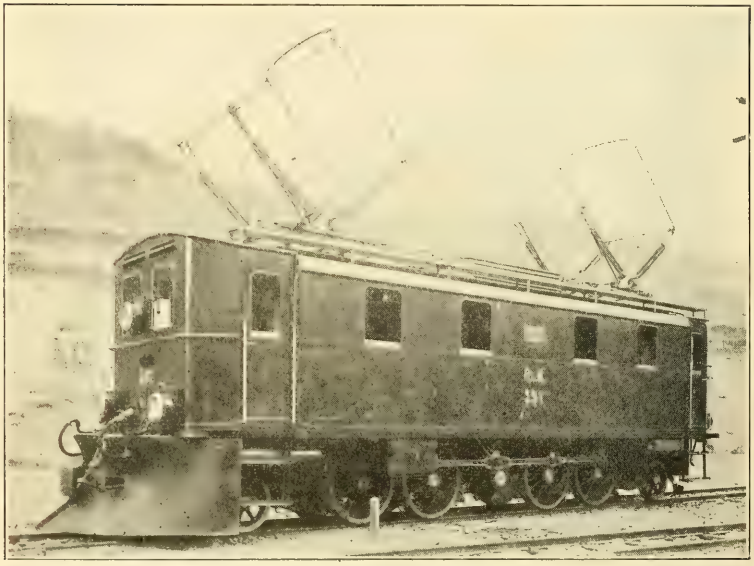


FIG. 29. RHATISCHE RAILWAY.

FIG. 30. BERNE–LÖTSCHBERG RAILWAY.

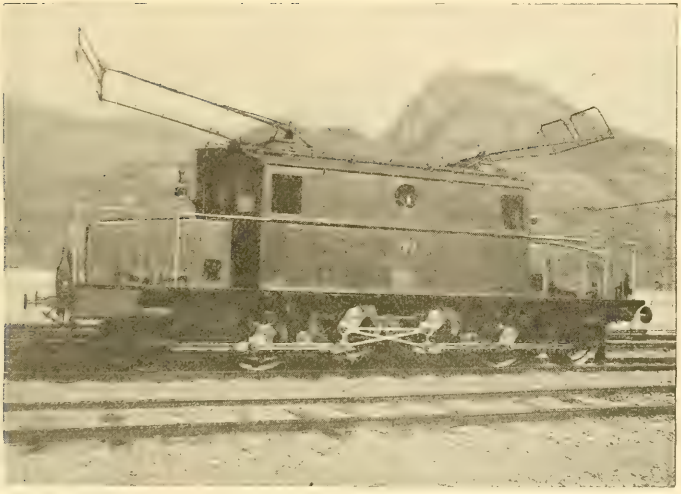


FIG. 31. SIMPLON TUNNEL RAILWAY.

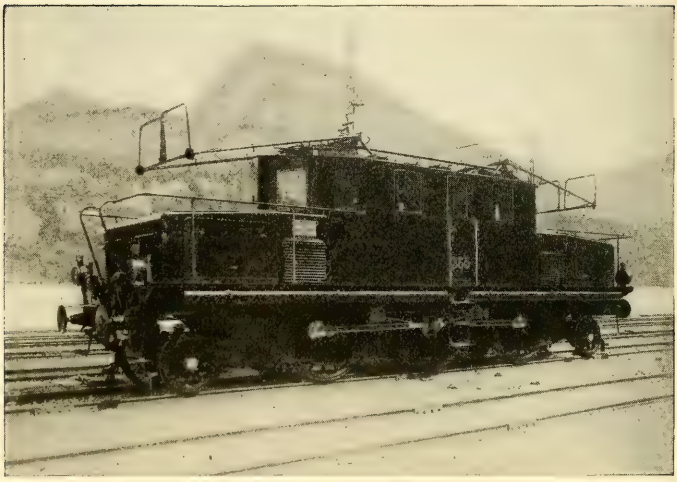


FIG. 32. SIMPLON TUNNEL RAILWAY.

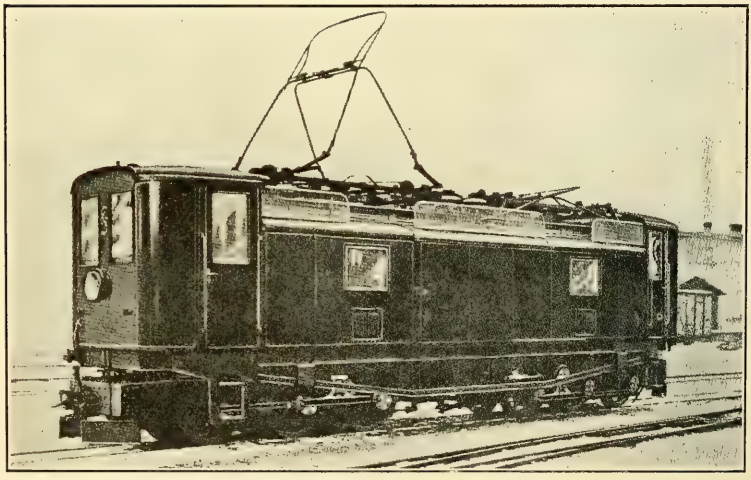


FIG. 33. ST. POLTEN-MARIAZELL-GUSWERK RAILWAY.

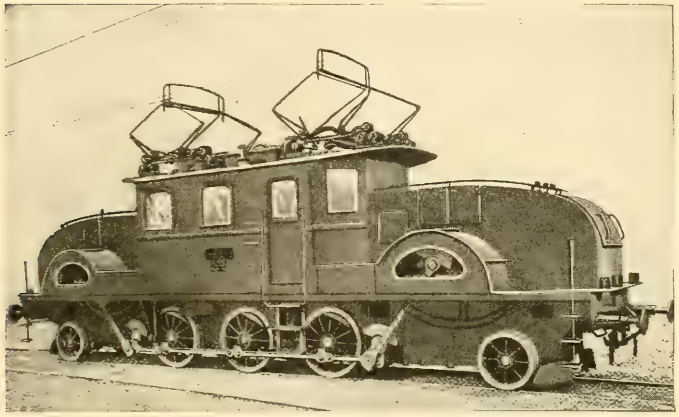


FIG. 34. WIESENTHAL RAILWAY.

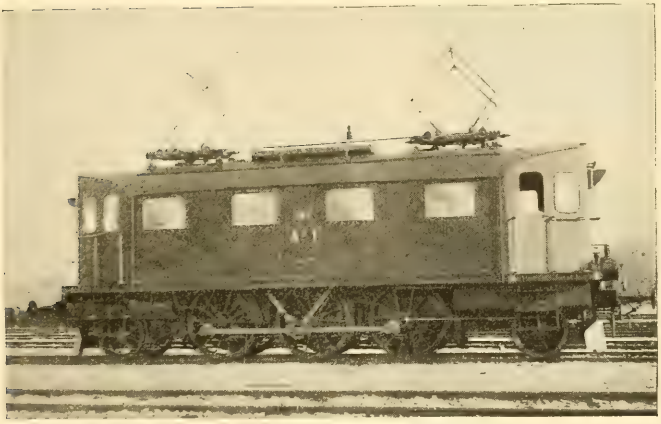


FIG. 35. WIESENTHAL RAILWAY.

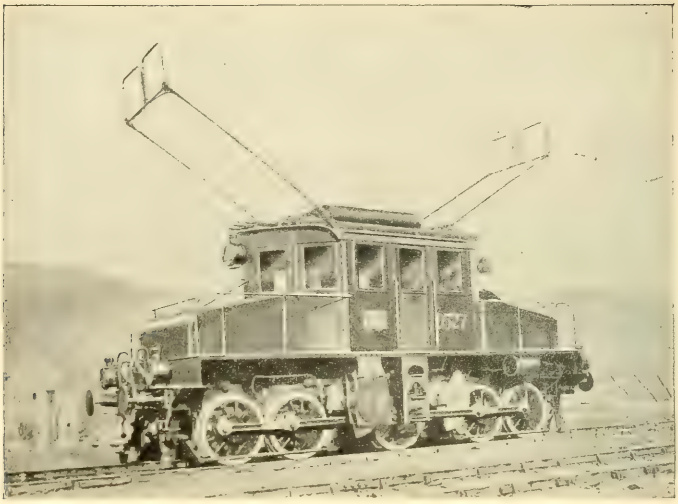


FIG. 36. VALTELLINA RAILWAY.

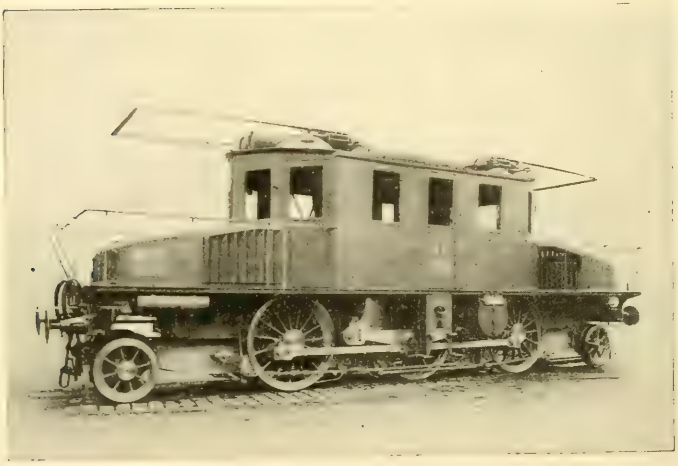


FIG. 37. VALTELLINA RAILWAY.

REPORT OF THE COMMITTEE ON STANDARDS CONCERNING CERTAIN RECOMMENDATIONS OF THE COMMITTEE ON HEAVY ELECTRIC TRACTION

1914–1915

Recommendation of Committee on Heavy Electric Traction:

(*a*) Clearance Line for Third-Rail Working Conductors. That the present Standard be modified according to changes indicated on diagram, between pages 556 and 557 of this report.

Action of Committee on Standards:

Approved the proposed changes.

Recommendation of Committee on Heavy Electric Traction:

(*b*) As Standard: Definition — Third-Rail Gauge. Recommended, the following definition: "Distance measured parallel to place of top of both running rails between gauge of nearest running rail and inside gauge line of third rail."

Action of Committee on Standards:

Adoption as Standard approved.

Recommendation of Committee on Heavy Electric Traction:

(*c*) As Recommended Design: Protection of Contact Rail where protected Third Rail is used for Rapid Transit Operation. Recommended where top contact rail is used, that Type A construction be established as Recommended Design; where underrunning type of third rail is used, that Type B construction be established as Recommended Design. These types are shown on page 557 of this report.

Action of Committee on Standards:

Adoption as Recommended Design approved.

Respectfully submitted,

C. F. Bedwell,
W. G. Gove,
E. R. Hill,
A. S. Richey,
J. W. Welsh,
C. S. Kimball,
E. B. Katte,
W. H. Sawyer,
F. R. Phillips,
J. H. Hanna,
C. H. Clark,
Martin Schreiber, *Vice-Chairman,*
H. H. Adams, *Chairman.*

PRESIDENT CRECELIUS:— Gentlemen, you have heard the report. Is there any discussion? If not, are you ready to act on the recommendation of the report (*a*), (*b*), (*c*), as shown on page 587. It would expedite matters if in one motion we can include these sections.

The Committee on Standards has approved these recommendations.

C. R. HARTE:—I move that the Convention approve recommendations (*a*), (*b*) and (*c*) of the Committee.

(Motion duly seconded, stated and carried.)

C. R. HARTE:— I move that the report as a whole be accepted and that the thanks of the Association be conveyed to the Committee for its admirable report.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— The next business is the Report of the Committee on Electrolysis, of which Prof. Albert S. Richey is Chairman. In the absence of Professor Richey I will ask Mr. Blair to kindly present the report of the Committee.

E. J. BLAIR:— In presenting this report it is not necessary to explain it at much length. Your Committee held one meeting during the year, because we all happened to be together at one time. Aside from that coincidence, I doubt if we would have called a special meeting, but would have transacted what business we had by correspondence. The reason for that is on account of the work of the National Joint Committee on Electrolysis, with which I hope you are all familiar. This Committee is compelled to mark time pending the production of the National Joint Committee's report; in other words, we are not in a position to make any definite recommendations ourselves. As you know we have representation on this National Joint Committee. The work of that Committee is one of the important matters going forward in the electric railway industry to-day, and when the National Joint Committee has reported there will be plenty for the Committee of your Association to do. We have consulted with, and made an effort to assist, the A. E. R. A. members of the Joint Committee on this subject, and of course will continue to do so. I asked Mr. Arnold, who is Chairman of the National

Committee, what he could say as to when the Report would be out and he stated that part of it was now in the hands of the Editing Committee.

I sincerely hope that the Committee on Electrolysis of this Association will be continued so that we can be ready to tackle the Report of the Joint Committee when published.

Aside from that statement, I would call your attention to the fact that your Committee also worked in conjunction with the Committee on Lightning Protection to harmonize the various views, insofar as they had a relation to the electrolysis problem.

REPORT OF THE COMMITTEE ON ELECTROLYSIS

To the American Electric Railway Engineering Association:

GENTLEMEN :— Your Committee on Electrolysis was continued during the present year with no special instructions except (a) to coöperate with the Association's representatives on the National Joint Committee on Electrolysis, and (b) to coöperate with various other standing committees through the Special Committee on Lightning Protection relative to the subject of grounds for line lightning arresters.

The Committee has held one meeting during the year, namely, at New York on April 28 and 29, 1915, all members of the Committee being present except Mr. Katté, who was represented by Mr. C. B. Martin.

The preliminary reports of the sub-committees of the National Joint Committee on Electrolysis have been submitted to members of your Committee and their criticisms and suggestions are being considered in the revision, which at this date (July 15) is not yet complete.

During the present year a Special Committee on Lightning Protection has been appointed by the Association consisting of one member each from the Committees on Power Distribution, Equipment, Block Signals and Electrolysis, the latter committee being represented by Mr. E. J. Blair. The Committee on Electrolysis was principally concerned in the method of grounding line lightning arresters and has heretofore been opposed to the grounding of the same arrester to both earth and track rails, feeling that this might add to the amount of current on foreign sub-surface structures. Other committees, however, such as those on Power Distribution and Equipment, have favored the connection of line lightning arresters to both an earth ground and the track rail on account of the more efficient protection which might be secured thereby.

The Special Committee on Lightning Protection has finally agreed that connection of the ground wires may be made to both the earth ground and the track rail where the current flow on such connection

would not exceed an average of one-quarter ampere during any twenty-four hour period. In checking up this current flow, it is agreed that the algebraic sum of currents flowing first in one direction and then in the other shall be used in determining the current flow. It is assumed that a resultant of more than one-quarter ampere average in either direction should be avoided.

Your Committee feels that if the current on lightning arrester grounds is limited to such a low amount as is specified by the Special Committee, no appreciable harm can result to foreign sub-surface structures, especially when the relatively low contact resistance between rail and earth in the usual forms of track construction is considered.

We therefore wish to express at least our tentative approval of the proposition of the Special Committee on Lightning Protection relative to lightning arrester grounds and request that member companies assist by forwarding us data relative to current flow over such connections between rail and earth grounds of lightning arresters where such exist.

The Committee wishes to call attention to a typographical error in the pipe resistance tables as printed in connection with the report of the Committee on Electrolysis in the 1913 Proceedings, page 379. The last three quantities at the lower right-hand corner of the page are printed:

138.
136.
146.

The correct figures are as follows:

13.9
13.9
14.8

This correction is formally brought to the attention of the Association here, although it has been informally called to your attention in the February, 1915, issue of AERA.

Respectfully submitted,

EDW. J. BLAIR,
E. B. KATTE,
GEO. W. PALMER, JR.,
ALBERT S. RICHEY, *Chairman,*
Committee on Electrolysis.

Discussion of Report of Committee on Electrolysis

I cannot emphasize too much the importance of your cooperating with the Committee on Electrolysis as requested in this Report and forwarding such information as the Committee may request.

In conclusion I would say, in behalf of the Committee, that you must not assume, because we are marking time, that the matter is out of our minds, and do not let it, therefore, get out of your mind. Keep thinking about it, and study ways and means of obviating electrolysis and if any of you in the course of the next year get some ideas on the electrolysis problem of which you want to unburden yourselves, I am sure that the ensuing Committee will appreciate them very much. I thank you.

PRESIDENT CRECELIUS:— Mr. Blair has outlined the status of this Committee in its relationship to other Committees in regard to the subject of electrolysis. The report carries no particular recommendation and no particular problems for your consideration at this time. However, we have a few minutes for discussion on the subject in general, and the Chair would be pleased to receive it. I will ask Mr. Jones if he is ready to open the discussion.

L. E. JONES:— On account of being in the signal and interlocking end of the work, I am not familiar with electrolysis exactly as it is considered here. I believe the Committee on Electrolysis worked in conjunction with the Committee on Lightning Protection on the matter of double grounds and I would like to ask a question in connection with the report on Lightning Protection. With reference to the table as given on page 33, I would inquire if those tests were made on isolated earth grounds.

L. E. JONES:— Based upon the results of these tests and upon tests made on rail grounds, the rail ground is proven to be twenty times more efficient than the earth ground. It has been my experience that an earth ground, which carries a small amount of current will increase in resistance very rapidly due to the drying out of the ground and where double grounds are installed there will be at best a small current flow from the earth ground to rail ground or vice versa.

I would suggest that if resistance tests were made on earth grounds that had actually operated in connection with rail grounds the results might prove that the earth grounds were of practically no value for the use in question.

W. H. DAVISON:— I have not much to say in reference to this subject, but thought I would speak about a method which one of the electric railroads on the Pacific Coast used to overcome this difficulty. They isolated one division on which they were having a great deal of trouble and connected two of their machines into a three-wire system, making one section of the trolley *positive*, another section *negative*, using the rail as the neutral. They found on test that a very small amount of current returned on the neutral wire, although the section was on a suburban line.

H. P. BELL:— I do not wish to criticise the work of your Committee on Electrolysis, but it appears to me that we are beating a little too much time on this subject. We, representing the electric railways of the United States, are accused and rightfully so, of being one of the main perpetrators of this "bug-bear, electrolysis," and it seems to me that it is up to us to get at some definite data on a workable basis for combating problems that arise from this subject.

In defense of my statement, I would call to your attention that to my definite knowledge, there are four corporations or individuals at the present time making the old drop of voltage test between two underground conductors, and appearing before the various railway companies with the result of their tests, not in the sense of showing a possible location of trouble, but in the sense of using this drop of voltage test to show the extent and seriousness of the trouble. This, of course, is a fallacy. In their discussions, the resistance of the ground between the conductors is not mentioned, and it is, of course, this resistance together with the voltage drop which governs the current flow or damaging element.

Your Committee is a young one, appointed in 1913, I believe. At the end of that year some definite valuable data bearing on pipe resistance, resistance of soils with various moisture content, and allied subjects had been obtained. At the 1914 Convention this Committee gave us something further in the nature of a progress report at the end of which report they stated that there were five headings under which they were working at that time and that the data on the same would be presented later. I presume that it is because of the appoint-

ment and work of the National Joint Committee that this data has never been given out. However, it seems to me that this data, which they outline under five headings, is something which we should have at hand, that we alone can gather and I believe it is data which should be worked up immediately. I do not care to make a motion on the subject, but think the matter should be called to the attention of our Committee on Subjects, and see to it that this data which relates decisively to the cause of electrolysis, covering the resistance and cost of lowering same on return circuits, the point of rebonding with economy, etc., is ready for our use when this matter comes to a head, and the member companies are called upon to spend millions of dollars to comply with some arbitrary low voltage drop per thousand feet of return circuit. Very few of the member companies would be able to keep their heads above water if laws are made and enforced prescribing as low voltage drops as are now prescribed (but not enforced) in some cities in this country and abroad. I think this matter should be called to the attention of our succeeding Committee, with the idea that they start in and work up a basis for some definite data on this subject.

C. R. PHENICIE:— I can only supplement Mr. Bell's statement that this subject, in my estimation, is extremely important, and it is being taken hold of not only by the National Joint Committee, but by municipal and civic bodies and by the Bureau of Standards. It seems to me that our Committee on Subjects and our Executive Committee ought to do all they can to assist this particular Committee in their development of the facts. There is a tendency apparently, by the Bureau of Standards, to set a standard for drop in voltage per 1,000 feet of track, approximately, I believe, 0.5 of a volt per 1,000 feet of track. The Bureau of Standards by setting that figure would be establishing a precedent, and we should have a voice in the matter and make it heard. I understand that it is intimated that figure may be made something like 0.3 of a volt per 1,000 feet of track, and it is a problem that we should coöperate in and endeavor to solve in the proper manner.

S. L. FOSTER:— The other gentlemen have covered the

ground I had in mind. Personally, I rather enjoyed the postponement of a decision by the Committee on the subject. It has so far been twenty years in preparation and if it should be postponed for twenty years more, I would like to see it done. It is a very serious matter and the way they will finally settle it, I am afraid, will be to call on the railroad people to put up immense quantities of negative feeders and several hundred per cent more substations. Some of the railroads are not in position to stand all these luxuries. Each year when the report of the Committee on Electrolysis comes in I look forward to it with great eagerness, to see what they have done, and when I find that they have limited their report to a page and half of matter I think, "Well, perhaps that is all right, after all."

E. J. BLAIR:— I feel very much embarassed, for this reason — that it looks as though your Committee had done absolutely nothing, and all of us hate to be put in that sort of a position. I think probably my remarks at the beginning of the report were unfortunate, when I stated that I did not believe it would have been necessary to have a meeting this year. Our eyes are wide open and eagerly waiting for the report of that National Joint Committee, and as you notice from our report, we have representation on that Committee, in fact, everything that can be done is being done by your own Committee on the subject.

I would also like to say that personally I believe there is more merit in Mr. Foster's remark than might appear on the surface. As to Mr. Phenicie's remark about the standard per thousand feet of track of the Bureau of Standards, I recognize the danger very clearly in that arbitrary standard, in that it will become spread throughout the country. It borders a bit on a catch phrase — one volt per thousand feet is very easy to say, and I think I can say that it would put some of the roads in bankruptcy to live up to it. Therefore, I hate to see it spread broadcast, as much as any of you, without combating it.

I would suggest that Mr. Bell, if he chooses, obtain the report of the Committee on Electrolysis that is on file at the New York office of the Engineering Association, and acquaint himself with the contents of it.

PRESIDENT CRECELIUS:— To relieve Mr. Blair in regard to the situation that develops in closing this discussion, let the Chair outline to you that in regard to the matter of electrolysis we have two distinct functions, one of interest in a technical way, in so far as it relates to electrical engineering, the other touches instantly a question of policy. In regard to the technical features of the subject, we are all, as electrical engineers, more or less familiar with the underlying fundamental facts. As regards the policy of the subject, that is different for it is a question so broad and intricate, so far reaching in its effect, its results and responsibilities, that it would seem to be highly desirable that it be evolved, rather, by a Joint Committee representing all the interests and societies interested in the subject. We have very full and very good representation upon such a Committee, and our representatives are looking after your interests to the utmost of their ability.

H. P. BELL:— My statement was not with the idea that there was any crying need for pressing the rapid development of this subject in law-making circles. I simply favored gathering data for our own defense when this subject comes to a head, which it now appears will not be very long hence. We should be able to present to these law makers not only our individual ideas arising from various localities, but also actual costs for installing and maintaining feeders, bonds, and all that sort of thing. We should have data collected from the various railroad companies of this Association to present an average cost over the United States, so that those who are interested could realize the cost that is imposed upon us, and the injury they will inflict upon us by making any arbitrary low drop per thousand feet of rail.

PRESIDENT CRECELIUS:— The policy in regard to the electrolysis question is in process of formation, and until that is formulated such information as that, of course, cannot accrue. The work of the Committee is on file in the archives of the secretary's office, and all member companies can have reference to it at any time. Mr. Blair, have you anything further to say in closing?

E. J. BLAIR:— I am glad Mr. Jones asked the question he

did so that it can go into the records of our meeting. Mr. Jones' sentiments, apparently, coincide with the Committee to a large extent. The mere fact that this one location that he describes destroyed the earth ground, simply backs up the opinion of the Committee that the rail ground is essential. As I said before, I am glad that Mr. Jones made his comments, as they will be of use for future Committees on electrolysis. The ratio of 20 to 1 obtained was from two different sets of tests, one set giving resistances from earth to track rail, and another set, in an entirely different locality, giving resistances of earth to lightning arrester grounds. Now then, your Committee found it impossible in the time that they had at their command to make tests on a piece of track that was free from outside influences. We would like to have done so, and any data Mr. Jones may have on that point will be appreciated.

PRESIDENT CRECELIUS:— A motion to receive the report and file it is in order.

C. R. HARTE:— I move that the report be received, with the thanks of the Association, and filed.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— We are now ready for the report of the Committee on Resolutions, which will be presented by Mr. Harte.

REPORT OF THE COMMITTEE ON RESOLUTIONS

To the American Electric Railway Engineering Association:

GENTLEMEN: Your Committee on Resolutions begs to submit its report as follows:

WHEREAS, Members of this Association have been most cordially treated and entertained at San Francisco and at all the cities where they have stopped en route to the Convention,

Be it Resolved, That this Association's heartiest thanks be given to all those who contributed to this welcome and to those who by the preliminary arrangements made possible this most successful Convention.

WHEREAS, The individual and collective work of this Association's officers and committeemen has contributed largely to the success of this Convention, and the advancement of this Association,

Be it Resolved, That the thanks of this Association be hereby expressed to President L. P. Crecelius, to the officers and to the members

of the various Committees for their successful efforts in furthering the interests of the organization, the companies and the individual members composing it.

WHEREAS, The American Electric Railway Manufacturers' Association has been of great assistance to our organization in its work and progress,

Be it Resolved, That this Association extends its thanks to the American Electric Railway Manufacturers' Association for their coöperation and many courtesies.

WHEREAS, During the past year, death has taken from among us members whom we highly esteemed and whose loss we deplore, including Past President Charles F. Baker,

Be it Resolved, That this Association tenders to the bereaved families its deep and sincere sympathy and condolences.

Respectfully submitted,

CHARLES RUFUS HARTE,
EDW. J. BLAIR,
Committee on Resolutions.

PRESIDENT CRECELIUS:— Gentlemen, you have heard the report of the Committee on Resolutions; what is your pleasure?

JOHN LINDALL:— I move the report be accepted.

(Motion duly seconded, stated and carried.)

PRESIDENT CRECELIUS:— We will have now the report of the Committee on Nominations. Mr. C. H. Clark, a member of that Committee, is here, and I will ask him to present the report.

REPORT OF COMMITTEE ON NOMINATIONS

To the American Electric Railway Engineering Association:

GENTLEMEN:— Your Committee held a meeting at the Hollenden Hotel, Cleveland, Ohio, on April 29, 1915, at which were present: Messrs. W. H. Roberts, C. H. Clark and W. J. Harvie, *Chairman.*

As a result of this meeting and by correspondence with those who were unable to be present, the Committee begs leave to report as its selection the following nominees for officers for the coming year:

President, John Lindall, Superintendent Rolling Stock and Shops, Boston Elevated Railway Co., Boston, Mass.

First Vice-President, F. R. Phillips, Superintendent of Equipment, Pittsburgh Railways Co., Pittsburgh, Pa.

Second Vice-President, G. W. Palmer, Jr., Electrical Engineer, Bay State Street Railway Co., Boston, Mass.

Third Vice-President, W. G. Gove, Superintendent of Equipment, Brooklyn Rapid Transit System, Brooklyn, N. Y.

Secretary-Treasurer, E. B. Burritt, 8 West 40th Street, New York, N. Y.

Members of the Executive Committee:

The officers and E. R. Hill, Consulting Engineer, Norfolk and Western Railway Co., New York, N. Y.; C. S. Kimball, Engineer Maintenance of Way, Washington Railway & Electric Co., Washington, D. C.; C. L. Cadle, Electric Engineer, New York State Railways, Rochester, N. Y.; C. F. Bedwell, Assistant Engineer, Public Service Railway Co., Newark, N. J.

Respectfully submitted,

W. H. Roberts,
C. H. Clark,
G. J. Smith,
Martin Schreiber,
W. J. Harvie, *Chairman,*
Committee on Nominations.

Note:—In accordance with the By-Laws the names of the above nominees were published in August, 1915, Aera, page 38.

President Crecelius:—Gentlemen, you have heard the report. What is your pleasure?

E. J. Blair:—Mr. Chairman, I move the acceptance of the report.

C. R. Harte:—I second the motion.

President Crecelius:—All in favor of the acceptance of this report, please signify so in the usual manner. Are there any objections? (No response.) None indicated.

E. J. Blair:—Mr. President, I think it is in order to move that the Secretary be instructed to cast the unanimous ballot of the Convention for the nominations.

President Crecelius:—It has been so moved, gentlemen. Does that meet with a second?

C. R. Harte:—I second the motion.

President Crecelius:—All in favor of having the Secretary cast the ballot of the Convention for the vote signify so by saying "Aye." Are there any objections? None noted. It is so ordered.

Acting Secretary Stocks:—Mr. President, the ballot is cast.

President Crecelius:—Gentlemen, the officers nominated

by the Committee on Nominations are declared elected. Just before asking Mr. Lindall to accept the Chair, I desire to express my appreciation of the good work of Mr. Gove, Mr. Blair, Mr. Clark, Mr. Stocks, Mr. Lindall, and others, who have come to the front in the absence of the Committee Chairmen and members prepared for the presentation of the reports.

The Chair appoints Mr. Foster and Mr. Yount as a Committee to escort President-elect Lindall to the Chair.

Mr. Lindall, I congratulate you. (Applause.) And in turning over the affairs of the Association, I want to say that, in retiring, I hope to retire only insofar as it affects the Chair. I hope to continue in the work of the Engineering Association to the best of my ability. I appreciate highly the honor you have conferred upon me and express my thanks for your very courteous consideration. (Applause.)

President-Elect Lindall:— Gentlemen: I am unable to find words to properly voice my feelings of appreciation and gratitude for the great honor which you have conferred upon me in electing me to the office of President of your Association for the coming year. I wish to assure you that I fully appreciate the responsibilities of the office. I realize the high standard of efficiency which has been set by our retiring President, and by many others before him. It shall be my main object during the coming year to see that the standard of efficiency is not lowered. To accomplish this, I bespeak, and must have, that same hearty coöperation which you have so generously given in the past. I am sure the Convention now drawing to a close will be long remembered by us as one of the most successful and satisfactory Conventions this Association has held, not only on account of the vast amount of useful work that has been accomplished during the year, but also on account of the fact that, by holding the Convention here, we have had an opportunity to see this beautiful and progressive city, as well as the most wonderful exposition which was ever held. But, the greatest reason, in my mind, is the fact that it has brought us in closer touch with our Western brothers. The Association knowns no lines of east, west, north or south. We are as a unity in the cause, that is

the advancement of the industry which we represent, and to the extent which we are able to advance that industry, to the same extent will our own individual interest be served.

Gentlemen, I thank you. (Applause.)

Evidently the office of President of this Association is a busy one. I am now due for a meeting of the American Executive Committee, and if there is nothing further to come before the Convention, a motion to adjourn is in order.

(On motion of Mr. C. H. Clark, duly seconded, the Convention then adjourned, *sine die.*)

LIST OF DISCUSSIONERS

(Arranged alphabetically according to name.)

The following is a complete list of the names, official titles and addresses of those who participated in the discussion at the Convention of the Engineering Association.

The page reference will be found in the General Index.

Bell, H. P., Electrical Engineer, San Francisco-Oakland Terminal Railways, Oakland, Cal.

Blair, E. J., Electrical Engineer, Metropolitan West Side Elevated Railway Co., Chicago, Ill.

Boggs, E. M., Chief Engineer, San Francisco-Oakland Terminal Railways Co., Oakland, Cal.

Brush, M. C., Second Vice-President, Boston Elevated Railway Co., Boston, Mass.

Carey, W. G., Manager, Railway Supply Sales, General Electric Co., Schenectady, N. Y.

Chamberlain, W. D., Assistant Engineer, United Railroads of San Francisco, San Francisco, Cal.

Clark, C. H., Engineer Maintenance of Way, The Cleveland Railway Co., Cleveland, Ohio.

Coen, F. W., Vice-President and General Manager, Lake Shore Electric Railway, Cleveland, Ohio.

Collins, W. H., General Manager, Fonda, Johnstown and Gloversville Railroad, Gloversville, N. Y.

Crecelius, L. P., Superintendent Motive Power, The Cleveland Railway Co., Cleveland, Ohio.

Davison, W. H., Chief Electrician, Peninsular Railway Co., San Jose, Cal.

Dempsey, J. J., Superintendent Transportation, Brooklyn Rapid Transit Co., Brooklyn, N. Y.

Denman, B. J., Vice-President, Tri-City Railway Co., Davenport, Ia.

Drew, J. H., President, Drew Electric and Manufacturing Co., Indianapolis, Ind.

Entwisle, E. B., Chief Engineer, Lorain Steel Co., Johnstown, Pa.

Fisher, R. B., Chief Engineer, The Buda Company, Chicago, Ill.

Foster, S. L., Chief Electrician, United Railroads of San Francisco, San Francisco, Cal.

Fuller, F. I., Vice-President, Portland Railway, Light and Power Co., Portland, Ore.

Gove, W. G., Superintendent, Equipment, Brooklyn Rapid Transit Co., Brooklyn, N. Y.

Harte, C. R., Construction Engineer, The Connecticut Company, New Haven, Conn.

Harvey, A. E., Chief Engineer, Metropolitan Street Railway, Kansas City, Mo.

Henry, C. L., President, Indianapolis and Cincinnati Traction Co., Indianapolis, Ind.

Jackson, W. P., Master Mechanic, San Francisco-Oakland Terminal Railways, Oakland, Cal.

Jones, L. E., Signal Engineer, San Francisco-Oakland Terminal Railways, Oakland, Cal.

Kupfer, C. A., Acting Assistant District Forester, District 5, United States Department of Agriculture, San Francisco, Cal.

Legare, B. P., Chief Engineer Maintenance of Way and Construction, United Railroads of San Francisco, San Francisco, Cal.

Lindall, John, Superintendent Rolling Stock and Shops, Boston Elevated Railway Co., Boston, Mass.

McIlraith, E. J., Superintendent Way and Structures, Puget Sound Traction, Light and Power Co., Seattle, Wash.

Mitchell, C. S., Comptroller, Pittsburgh Railways Co., Pittsburgh, Pa.

Nachod, C. P., Nachod Signal Co., Philadelphia, Pa.

Neal, J. H., General Auditor, Boston Elevated Railway Co., Boston, Mass.

Nicoll, H. A., General Manager, Union Traction Company of Indiana, Anderson, Ind.

Perrin, L. M., Signal Engineer, Interstate Commerce Commission, San Francisco, Cal.

Phenecie, C. R., General Manager, Wisconsin Public Service Co., Green Bay, Wis.

Priest, E. D., General Electric Co., Schenectady, N. Y.

Shannahan, J. N., Vice-President and General Manager, Newport News and Hampton Railway, Gas and Electric Co., Hampton, Va.

Stocker, L. W., Editor, *Electric Traction,* San Francisco, Cal.

Stocks, C. W., American Electric Railway Association, New York, N. Y.

Yount, J. M., Master Mechanic, United Railroads of San Francisco, San Francisco, Cal.

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